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AGRICULTURAL  
ARITHMETIC

STRATTON AND REMICK

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# AGRICULTURAL ARITHMETIC



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# AGRICULTURAL ARITHMETIC

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1916

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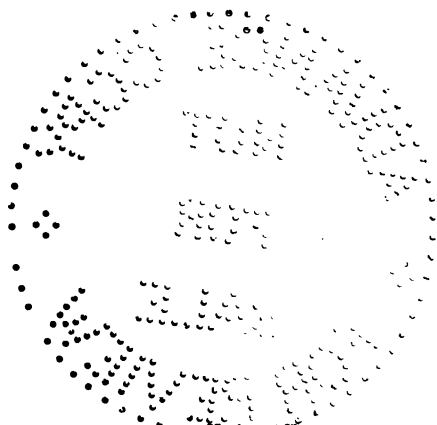
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Set up and electrotyped. Published June, 1916.



Norwood Press  
J. S. Cushing Co. — Berwick & Smith Co.  
Norwood, Mass., U.S.A.

## PREFACE

THE design of this book is to provide a brief course in arithmetic for students interested in agriculture. It is the direct outgrowth of a need for such material in our work with the students in the School of Agriculture of the Kansas State Agricultural College. This text will be found adapted to the requirements of advanced classes in elementary schools in communities outside the city, the agricultural high schools, and other high schools having agricultural courses. It presupposes a fair knowledge of the principles underlying arithmetic and some facility in the use of arithmetical forms. Since students even from the same school differ greatly in their abilities to handle readily the ordinary combinations of numbers, it has been found advisable to devote some time to a review of the four fundamental operations, common fractions, and decimals.

The purpose throughout the book has been, first of all, to present the basic principles of arithmetic. To accomplish this end use is made of the problems which are met in daily experience. Boys and girls of any community can master the principles

of arithmetic to the best advantage when those principles are applied in terms of their own environment. Many boys and girls in communities outside of large cities will, moreover, have little use for purely commercial arithmetic, and if they do, they will come to it better from the training they received in the natural way with real problems as they know them.

The agricultural data of the problems are based upon the most recent reports of the various State Experiment Stations, and of the United States Department of Agriculture. From the facts so displayed in their mathematical relations it is hoped that the students may not only obtain sufficient material for drill in arithmetical processes but also be led to a better appreciation of farm life.

W. T. STRATTON.  
B. L. REMICK.

APRIL, 1916.

## ACKNOWLEDGMENTS

THE authors wish to acknowledge their indebtedness to Miss Daisy Zeininger, Mr. A. R. Fehn, and Miss Ina Holroyd of the department of mathematics and to Mr. Hugh Durham, assistant to the dean of agriculture, for their helpful criticism after having used the material in pamphlet form in their classes at the Kansas State Agricultural College; also to Professor L. E. Call of the department of agronomy and Professor H. L. Kent, principal of the School of Agriculture and associate professor of education, for their reading of the manuscript from an agricultural and from an educational point of view.

W. T. S.  
B. L. R.



# CONTENTS

	PAGE
ADDITION . . . . .	1
Addition of United States Money . . . . .	4
SUBTRACTION . . . . .	7
Subtraction of United States Money . . . . .	8
MULTIPLICATION . . . . .	10
Multiplication of United States Money . . . . .	13
DIVISION . . . . .	15
Division of United States Money . . . . .	19
COMMON FRACTIONS . . . . .	24
DECIMAL FRACTIONS . . . . .	36
FARM ACCOUNTS . . . . .	55
DENOMINATE NUMBERS . . . . .	62
GRAPHS AND THEIR APPLICATIONS . . . . .	79
MEASUREMENTS . . . . .	86
PRACTICAL MEASUREMENTS . . . . .	99
Plastering, Papering, Painting, Roofing, Board Measure, Flooring, Cement Construction, Brickwork and Stonework, Temperature, Longitude and Time, Standard Time, Government Land Measure.	
PERCENTAGE . . . . .	131
Group Problems — Seeds, Dairying, Poultry, Fertilizers, Spraying, Soils . . . . .	141
GAIN AND LOSS . . . . .	154
COMMISSION . . . . .	158
TAXES . . . . .	162
INSURANCE . . . . .	166
INTEREST . . . . .	170

	PAGE
BUSINESS PAPERS . . . . .	180
POWERS AND ROOTS . . . . .	184
RATIO AND PROPORTION . . . . .	192
Practical Applications of Ratio—Specific Gravity, Ra- tions, Nutritive Ratio, Balanced Rations, Silos . . . . .	195
Practical Applications of Proportion—Levers . . . . .	216
MISCELLANEOUS PROBLEMS . . . . .	219
APPENDIX I . . . . .	235
Weights of Produce, Important Facts, Special Rules, Hay Measurements.	
APPENDIX II . . . . .	238
Miscellaneous Measures.	

# **AGRICULTURAL ARITHMETIC**





# FUNDAMENTAL OPERATIONS

## ADDITION

### Study Exercise

**1. Addition** is the process of uniting two or more numbers into one number called the sum.

Speed and accuracy in addition depend largely upon the ability to combine two or more numbers into one number, and upon constant drill. For several days a few minutes of each recitation period should be spent in drill on exercises in addition.

Add the following columns:

1.	2.	3.	4.	5.	6.
213	8267	549	742	785	8645
862	1796	753	816	905	2619
594	9229	927	174	783	9641
391	7819	289	367	427	1862
964	8637	918	816	716	6529
236	9088	187	952	849	5931
567	4245	719	657	739	1479
198	3278	497	185	598	5327
671	8931	952	189	379	7536
<u>278</u>	<u>9677</u>	<u>417</u>	<u>579</u>	<u>198</u>	<u>2479</u>

**Oral and Written Exercise**

2. Find the sum first without rewriting, and then after rewriting the columns.

1. 176, 64, 368, 742, 984, 157, 18, 76, 591, 723, 615, 458, 723, 659.

2. 9341, 8967, 6259, 4637, 2687, 5412, 4219, 6528, 6534, 7682, 1874.

3. 873, 849, 196, 264, 973, 878, 585, 662, 791, 653, 634, 972.

4. 898, 626, 786, 741, 872, 677, 823, 997, 812, 761, 876, 873.

5. 569, 752, 625, 893, 369, 175, 461, 729, 527, 538, 649, 129, 746.

6. 731, 998, 431, 962, 877, 689, 398, 999, 689, 476, 849, 327.

7. 4894, 8796, 7842, 4988, 8921, 7639, 7289, 7877, 7638, 4981, 3827, 4963.

8. 829, 696, 628, 124, 297, 787, 382, 789, 271, 197, 687, 397, 241, 473, 420.

9. The circulation of a daily paper was 34,699, 34,464, 34,510, 34,541, 33,539, 34,618, 34,686, 34,537, 34,588, 34,709, 34,681, 33,506, 34,715, 34,564, 34,556, 34,579, 34,631, 34,599, 33,343, 34,731, 34,534, 34,564, 34,658, 34,646, 34,606, 34,600, 33,414, 34,568, 34,443, 34,498, 33,563. What was the total circulation for the month?

### Checking Addition

3. In addition there are several ways of checking the result, but only two are worthy of consideration here.

*Adding the columns up and then down.* Add the columns, beginning at the top. Then add them again, beginning at the bottom. If the sums are found to be the same, the result is probably correct. The check comes from the fact that different combinations of figures are used in each addition, and thus the danger of making the same mistake over and over again is eliminated.

*Casting out the nines.* To check by casting out the nines, first add the digits, and, when the sum equals or exceeds nine, drop the nine. Do the same for the result and the remainders obtained. If the final remainder equals the remainder of the sum, the result is probably correct. For example :

463	4, remainder
327	3, remainder
784	1, remainder
914	5, remainder
748	1, remainder
318	3, remainder
536	5, remainder
679	4, remainder
<u>4769</u>	8, remainder
8 is the final remainder	

**Checking Exercise**

4. Find the total number of horses, mules, milch cows, sheep, hogs, and beef cattle found in the ten leading live stock states. Also from the table find the total number of animals in each of the states given. Check by the two methods suggested above.

STATE	HORSES	MULES	MILCH COWS	SHEEP	HOGS	BEEF CATTLE
Illinois	1497	151	1049	1068	4640	1266
Kansas	1169	218	698	326	2808	1872
Indiana	838	84	634	1372	4031	1266
Iowa	1568	57	1394	1201	9689	2773
Missouri	1095	333	822	1755	4491	1504
Wisconsin	652	3	1504	874	2051	1146
Ohio	901	24	887	3694	3578	855
Texas	1158	703	1034	2032	2544	5177
Nebraska	1059	85	613	382	1104	2002
New York	609	4	1495	911	777	894

NOTE. — The numbers above are thousands — the three ciphers are omitted.

**ADDITION OF UNITED STATES MONEY**

5. In addition of United States money the numbers to be added should be so placed that the decimal points shall stand in a vertical line. Add as in whole numbers. The decimal point in the sum should stand directly under the decimal points of the numbers to be added.

**Written Exercise**

6. Find the sum of the following :
1. \$8.65, \$9.56, \$16.76, \$18.24, \$17.73, \$93.50, \$1.97, \$9.32, \$6.84.
  2. \$93.20, \$77.42, \$65.94, \$43.59, \$182.47, \$65.79, \$176.44, \$89.57.
  3. \$118.46, \$92.75, \$169.84, \$145.38, \$71.62, \$233.90.
  4. \$362.45, \$277.53, \$916.37, \$49.12, \$635.26, \$528.05.
  5. \$806.72, \$1215.64, \$2390.29, \$1914.40, \$1750.75.
  6. \$9803.14, \$736.45, \$10,041.82, \$1667.15, \$5981.38.

**Written Problems**

7. 1. A farmer sold the following products during the year: 3 horses at \$255 each; 24 hogs for \$478.60; 14 steers for \$692.75; 360 bushels of potatoes for \$213.22; 40 chickens for \$24.80; 110 dozen eggs for \$23.10; and 550 bushels of oats for \$220. Find the total amount of the sales.

2. The estimated cost of raising an acre of wheat is as follows: plowing, \$1.38; preparing land, \$1.06; seed, \$1.12; drilling, \$.40; cutting, \$1.00; threshing, \$.80; labor in threshing, \$.83; hauling to market, \$.43; rent on land, \$2.40; taxes, \$.25. What is the estimated cost of raising an acre of wheat?

3. The estimated cost of raising an acre of corn is as follows: seed, \$.13; plowing, \$1.31; preparing land, \$.54; planting, \$.24; cultivating, \$1.81; husking, \$3.46; rent and taxes, \$2.90. What is the estimated cost of raising an acre of corn?

4. What was the entire cost of a silo if the foundation cost \$17.53; lumber, \$5; staves, \$28.84; hauling, \$9; hoops, \$21.95; nails and bolts, \$5.70; labor, \$17.50; painting, \$12.50; incidental expenses, \$9.50?

5. The actual cost of one of the silos built at the Iowa Station was distributed as follows: excavation, \$5.65; foundation, \$35.10; hoops and braces, \$46.50; inside walls, \$65; outside walls, \$37.50; roof, \$11.62; chute, \$16.30; hardware, \$12.15; labor, \$25. What was the entire cost of the silo?

6. The amount of money in circulation in the United States during 1915 was distributed as here given: gold coin, \$657,944,193; gold certificates, \$931,390,259; silver dollars, \$70,724,311; silver certificates, \$482,892,121; other silver, \$161,565,114; treasury notes, \$2,388,789; United States Bank notes, \$336,974,240; national bank notes, \$1,050,869,169. What was the total amount of money in circulation?

## SUBTRACTION

### Study Exercise

**8. Subtraction** is the process of finding the difference between two numbers.

The number from which we subtract is called the **minuend**.

The number to be subtracted is called the **subtrahend**.

The **remainder**, or difference, is the result obtained by subtraction.

Subtract :

1.	2.	3.	4.	5.	6.	7.
8423	7549	6371	9420	7421	5487	8412
<u>2089</u>	<u>3507</u>	<u>1729</u>	<u>2679</u>	<u>3268</u>	<u>4218</u>	<u>4189</u>

### Oral Exercise

**9. Give the answer :**

- |                   |                    |
|-------------------|--------------------|
| 1. $7836 - 429 =$ | 7. $1003 - 548 =$  |
| 2. $763 - 89 =$   | 8. $872 - 428 =$   |
| 3. $645 - 247 =$  | 9. $1043 - 769 =$  |
| 4. $963 - 689 =$  | 10. $4321 - 978 =$ |
| 5. $689 - 437 =$  | 11. $1007 - 967 =$ |
| 6. $823 - 479 =$  | 12. $451 - 265 =$  |



- |                    |                    |
|--------------------|--------------------|
| 13. $1024 - 198 =$ | 16. $1256 - 958 =$ |
| 14. $686 - 298 =$  | 17. $2150 - 359 =$ |
| 15. $750 - 543 =$  | 18. $1025 - 493 =$ |

### Checking Subtraction

10. To check a problem in subtraction, find the sum of the subtrahend and the remainder. If their sum equals the minuend, the work is probably correct.

For example : From 5763 take 3872.

#### Process

5763

3872

1891 *Ans.*

**Explanation :** Without rewriting, add the numbers in the subtrahend and remainder, and check with the minuend.

Subtract and check the following :

1.	2.	3.	4.	5.	6.
9873	96763	68347	78865	92476	78421
<u>4584</u>	<u>78974</u>	<u>57638</u>	<u>34968</u>	<u>64384</u>	<u>58465</u>

### SUBTRACTION OF UNITED STATES MONEY

11. In subtraction of United States money the numbers to be subtracted should be so placed that the decimal points stand in a vertical line. Subtract as in whole numbers. The decimal point in the remainder should stand directly under the decimal points of the numbers to be subtracted.

1. From \$197.17 take \$89.97; from \$76.43 take \$43.465.

2. From \$530.38 take \$416.71; from \$325.62 take \$219.74.

3. From \$604.19 take \$511.28; from \$498.16 take \$269.77.

4. From \$368 take \$314.06; from \$805.10 take \$732.49.

### Written Problems

12. 1. A man deposited in a bank \$970.35. He checked out at one time \$269.75, at another \$180.13, at another \$347.86, and at another \$45.80. How much remained?

2. A school district has a levy of \$750 for school purposes. What is left on hand at the end of the year if the following amounts were paid: teacher's salary, \$480; fuel, \$47.50; repairs, \$35.75; equipment, \$40; incidentals, \$37.50?

3. What will be the change if a \$10 bill is presented in payment for each of the following bills: \$6.33; \$8.23; \$5.95; \$4.72; \$3.45; \$.76; \$.15; \$.20?

4. What will be the change if a \$20 bill is presented in payment for each of the following bills: \$17.32; \$9.76; \$18.21; \$14.87; \$9.62; \$12.55; \$6.18; \$7.96?

5. A carload of cattle sold for \$3457.40. What was left after paying the following expenses: commission, \$15.60; freight, \$21; yardage, \$4.70; feed on the road, \$2.85?

## MULTIPLICATION

### Study Exercise

**13. Multiplication** is the process of repeating a number a certain number of times.

The number to be repeated is called the **multiplicand**.

The number showing the number of times the multiplicand is to be repeated, is called the **multiplier**.

The result obtained by performing the multiplication is called the **product**.

The multiplicand may be either an abstract or a concrete number, but the multiplier is always abstract.

Since speed and accuracy can only be attained by drill, the student should practice on problems in multiplication until he is entirely familiar with the process, and especially with the short rules of multiplication.

### Written Exercise

**14. Multiply:**

<b>1.</b> 397 68 <hr/>	<b>2.</b> 383 37 <hr/>	<b>3.</b> 864 59 <hr/>	<b>4.</b> 5963 478 <hr/>	<b>5.</b> 4246 629 <hr/>
<b>6.</b> 7269 943 <hr/>	<b>7.</b> 8327 684 <hr/>	<b>8.</b> 9873 763 <hr/>	<b>9.</b> 8967 479 <hr/>	<b>10.</b> 9003 7008 <hr/>

**SHORT METHODS IN MULTIPLICATION**

**15.** The most important short methods of multiplication are the following :

1. *To multiply by 10, 100, 1000, etc., annex one, two, three, etc., ciphers to the multiplicand.*

2. *To multiply by the factors of a number rather than to multiply by the number itself. For example, to multiply by 18, first multiply by 6 and then by 3. The result is thus obtained without addition, and the multiplication has been performed without rewriting.*

3. *To multiply by 19, 29, 39, etc., multiply by the next higher number and subtract the number from the result. For example, to multiply by 99, first multiply by 100, i.e. annex two ciphers, and then subtract the number.*

Apply short methods in the following exercises :

1. Multiply 247 by 100.

$$247 \times 100 = 24700 \text{ (annex two ciphers).}$$

2. Multiply 376 by 28.

$$376 \times 28 = 376 \times 4 \times 7 = 1504 \times 7 = 10528.$$

3. Multiply 367 by 29.

$$29 \times 367 = 3(10 \times 367) - 367 = 11010 - 367 = 10643.$$

**Written Exercise**

**16.** Perform the following multiplications, using as far as possible the short methods of multiplication.

1. Multiply 9247 by 10, 100, 1000, 10000.
2. Multiply 7483 by 9, 19, 29, 39, 49, 59, 69, 79, 89, 99.
3. Multiply 5384 by 18, 24, 28, 36, 42, 56, using the factors.
4. Multiply 768 by 47; 8549 by 87; 4581 by 23; 7538 by 269.
5. Multiply 1001 by 287; 56843 by 98; 29378 by 89; 78635 by 457.
6. Multiply 96 by 78 by 37; 45 by 28 by 79; 65 by 73 by 87.
7. Multiply 65,942 by 758; 78,658 by 4937; 6389 by 574.
8. Multiply 3258 by 64 by 94; 468 by 8276.

### Written Problems

17. 1. One cubic foot of soil weighs about 79 pounds. The soil 8 inches deep on an acre contains 29,040 cubic feet. What is its weight?
2. Multiply the sum of 746 and 388 by three times their difference.
3. If a cow averages 29 pounds of milk a day, how many pounds does she produce in a year?
4. Sound travels 1130 feet a second. How far will it travel in 43 seconds?
5. A wheat field of 17 acres yields 26 bushels an acre. How many bushels are produced?

6. If a dairy cow eats 38 pounds of silage a day, how many pounds of silage will it take to feed a herd of 24 cows for 160 days?

**Checking Multiplication**

18. The best method of checking the result in multiplication is to interchange the multiplier and multiplicand. Thus, to check the product of 894 by 635, multiply 635 by 894. If the same product is obtained in each case, the result is probably correct.

Multiply and check :

1.	2.	3.	4.	5.	6.	7.
6743	7356	2845	2367	7429	4198	82,479
<u>574</u>	<u>549</u>	<u>7031</u>	<u>2581</u>	<u>689</u>	<u>679</u>	<u>19</u>

**MULTIPLICATION OF UNITED STATES MONEY**

19. In multiplication of United States money multiply as in whole numbers, and point off the dollars from the cents and mills.

Multiply :

1.	2.	3.	4.
\$46.75	\$64.58	\$86.41	\$56.46
<u>18</u>	<u>36</u>	<u>96</u>	<u>78</u>
5.	6.	7.	8.
\$89.63	\$472.35	\$100.35	\$964.83
<u>69</u>	<u>64</u>	<u>403</u>	<u>38</u>

**Written Problems**

20. 1. If the cost of raising a crop of wheat is \$9.67 an acre, what is the total cost to raise 65 acres?

2. Corn can be produced for about \$10.06 an acre. What will be the cost to raise 65 acres?

3. If the wheat in problem 1 averaged 18 bushels an acre and is valued at 95¢ a bushel, what was the profit?

4. If the corn averaged 35 bushels an acre and was valued at 65¢, what was the profit? Compare with the result of problem 3.

5. What is the value of a carload of 58 hogs averaging 316 pounds at 8¢ a pound?

6. The United States imported 38 million bunches of bananas during a certain year. Find their cost at an average value of 24¢ a bunch.

7. What will be the cost of a fertilizer for 4.5 acres of potatoes at \$3.75 per acre?

8. If in spraying an apple tree four times with Bordeaux mixture the cost is 12¢ for the material and 23¢ for labor, what will it cost to spray 85 trees four times?

9. What will be the cost of spraying the trees in problem 8 if a lime-sulphur treatment is used with an average cost of 17¢ per tree for the material and with the labor cost the same?

# DIVISION

## Study Exercise

**21. Division** is the process of separating a number into equal parts.

The number to be separated is called the **dividend**.

The number that shows into how many parts the dividend is to be separated is called the **divisor**.

The result obtained by division is called the **quotient**.

### SHORT DIVISION

Divide 6879 by 3.

<b>Process</b>	<b>Explanation:</b> 6 thousands divided by 3 equals 2 thousands; 8 hundreds divided by 3 equals 2 hundreds, with a remainder of 2 hundreds; 2 hundreds plus 7 tens equals 27 tens; 27 tens divided by 3 equals 9 tens; 9 units divided by 3 equals 3 units. Therefore the quotient is 2293.
$\begin{array}{r} 3 \overline{)6879} \\ \underline{2293} \end{array}$	

### LONG DIVISION

<b>Process</b>	<b>Explanation:</b> 576 thousands divided by 425 equals 1 thousand, with a remainder of 151 thousands; 151 thousands plus 4 hundreds equals 1514 hundreds; 1514 hundreds divided by 425 equals 3 hundreds, with a remainder of 239 hundreds; 239 hundreds plus 0 tens equals 2390 tens; 2390 tens divided by 425 equals 5 tens, with a remainder of 265 tens; 265 tens plus 8 units equals 2658 units; 2658 units divided by 425
$\begin{array}{r} 13561\frac{18}{425} \\ 425 \overline{)576408} \\ \underline{425} \phantom{00} \\ 1514 \phantom{00} \\ \underline{1275} \phantom{00} \\ 2390 \phantom{00} \\ \underline{2125} \phantom{00} \\ 2658 \phantom{00} \\ \underline{2550} \phantom{00} \\ 108 \end{array}$	



equals 6 units, with a remainder of 108 units. Therefore the quotient is 1356 with a remainder of 108 or  $1356\frac{108}{111}$ .

### Oral Exercise

**22.** Divide in short division :

1. Divide 68, 642, 568, 4628, 468, 864, 972, 794, 9755, 371, 279 by 2, 3, and 4.
2. Divide 144, 657, 489, 843, 198, 1758, 4275, 63,285, 8537, 4631 by 3 and 5.
3. Divide 288, 1456, 5348, 5228, 5608, 9417, 57,436, 18,764 by 4 and 6.
4. Divide 359, 1375, 20,849, 3148, 50,842, 3749, 2748, 5648, 3298, 9076 by 7.
5. Divide 6785, 4873, 9864, 76,548, 35,638, 53,789, 10,856, 190,834 by 8 and 9.

### Written Exercise

**23.** Divide in long division :

1. Divide 378 by 14; 1411 by 17; 1728 by 12; 2401 by 49.
2. Divide 5208 by 56; 5060 by 46; 9417 by 73; 21,465 by 81.
3. Divide 10,252 by 97; 8795 by 103; 13,651 by 89; 19,407 by 113.
4. Divide 19,404 by 231; 28,763 by 314; 49,706 by 467.
5. Divide 690,014 by 523; 803,277 by 633; 746,292 by 809.

**Tests of Divisibility**

**24.** In order to determine what factors will *exactly* divide a number, the following *tests of divisibility* of numbers are suggested :

A number is divisible by 2 if it ends in an even number, by 3 if the sum of the digits is divisible by 3, by 4 if the number formed by the last two digits of the number is divisible by 4, by 5 if the number ends in 5 or zero, by 6 if divisible by 2 and 3, by 8 if the number formed by the last three digits is divisible by 8, by 9 if the sum of the digits is divisible by 3 twice, and by 10 if the number ends in zero.

Test the divisibility of the following numbers and tell what integers will exactly divide each number.

1. 386    3. 720    5. 6375    7. 6789    9. 1548  
2. 159    4. 2912    6. 7930    8. 40752    10. 31,581

**Checking Division**

**25.** To check the work in division, multiply the quotient by the divisor and to this product add the remainder, if any.

Divide and check the following :

- |                  |                    |
|------------------|--------------------|
| 1. 179 ÷ 5.      | 6. 52,968 ÷ 236.   |
| 2. 6184 ÷ 4.     | 7. 7162 ÷ 24.      |
| 3. 37,121 ÷ 163. | 8. 216,509 ÷ 127.  |
| 4. 367 ÷ 13.     | 9. 9086 ÷ 11.      |
| 5. 45,075 ÷ 15.  | 10. 754,190 ÷ 105. |

**Short Methods in Division**

**26.** The most important short methods in division are the following :

*To divide by 10, 100, 1000, etc., set off as many figures at the right of the dividend as there are ciphers in the divisor. The figures thus set off are the remainder, and the other figures are the quotient.*

Division may often be performed more easily by *using the factors of the number as divisors*. For example, to divide by 18, first divide by 3 and then by 6.

Apply short methods in the following exercises :

1. Divide 42,713 by 100.

**Process**

$$427 \overline{) 13} = 427 \frac{13}{100}$$

2. Divide 3405 by 15.

**Process**

$$\begin{array}{r} 5 \overline{) 3405} \\ 3 \overline{) 681} \\ \hline 227 \text{ Ans.} \end{array}$$

**Written Exercise**

**27.** Use short methods.

1. Divide 5268 by 12, 100, 1000.
2. Divide 8498 by 10, 14, 21.
3. Divide 23,040 by 16, 72, 96.
4. Divide 7560 by 35, 60, 45.
5. Divide 17,010 by 90, 42, 54.

**DIVISION OF UNITED STATES MONEY**

**28.** To divide in United States money, proceed as in whole numbers. Write the first figure of the quotient over the right-hand figure of the first partial dividend. Place the decimal point in the result, directly over the decimal point in the dividend.

In case both dividend and divisor represent amounts of money, reduce them to cents and then divide as usual.

1. Divide \$ 528.08 by 92.

$$\begin{array}{r}
 \text{Process} \\
 \$5.74 \text{ Ans.} \\
 92 \overline{)528.08} \\
 \underline{460} \phantom{00} \\
 680 \phantom{00} \\
 \underline{644} \phantom{00} \\
 368 \phantom{00} \\
 \underline{368} \phantom{00} \\
 0
 \end{array}$$

**Written Exercise**

- 29.** Find the quotient.

- |                     |                      |
|---------------------|----------------------|
| 1. \$22.68 + 14.    | 6. \$985.09 + 23.    |
| 2. \$22.68 + \$14.  | 7. \$1662.60 + 51.   |
| 3. \$65.25 + 18.    | 8. \$1791.70 + 46.   |
| 4. \$1166.20 + 28.  | 9. \$2734.40 + 64.   |
| 5. \$74.50 + \$.25. | 10. \$443.20 + \$32. |

**Written Problems**

30. 1. A farmer paid \$64,650 for 862 acres of land. What was the price per acre?

2. If \$250, invested at  $6\frac{1}{2}\%$  simple interest, yield \$16.25 a year, how many years will be required for it to double itself?

3. How many pounds of sugar at 6¢ a pound can be had in exchange for 17 dozen eggs at 24¢ a dozen?

4. The approximate value of the corn crop of Morgan County, Illinois, in 1910 was \$2,950,000, and the crop acreage 128,348. Find the value of the yield per acre.

5. The area of the farm lands of Iowa in 1910 was about 34 million acres, and their value 3260 million dollars. What was their average value per acre?

6. According to recent statistics the annual wages paid to the 222,264 iron and steel workers in the United States during a certain year was \$120,723,092. What was the average wage of each earner?

**REVIEW OF FUNDAMENTAL OPERATIONS****Written Exercise**

31. Perform the operations indicated.

1.  $8462 + 5179 - 6384 - 2176 = ?$

2.  $486 - 317 + 479 + 821 - 782 - 238 = ?$

3.  $6917 - 418 - 1670 + 592 = ?$
4.  $783 \times 985 \div 428 = ?$
5.  $745 \times 348 \div 87 = ?$
6.  $5275.50 \div 5.66 + 247 - 499 = ?$
7.  $403 \div 13 + 46 \times 15 - 124 = ?$

(Perform all multiplication and division before adding and subtracting.)

8.  $4914 \div 7 - 652 \times 19 + 234 = ?$
9.  $89 \times 74 \times 153 \div 91 = ?$
10. Select the numbers from the following that are exactly divisible by 2, 3, 4, 5, 6, 7, 8, 9: 376, 653, 981, 4328, 35,456, 92,125, 82,601, 9212, 3730, 3645, 42,563, 67,332, 85,563, 9656, 9985, 2708, 61,083, 98,254, 89,576.

### Written Problems

32. 1. A horse is fed 16 pounds of hay per day. How many tons will be required to keep the horse a year?

2. In five bins of wheat there are 567 bushels, 237 bushels, 478 bushels, 654 bushels, and 825 bushels. How many bushels in the five bins?

3. At Columbia, Mo., the total wind movement, according to the U. S. weather report, for July was 4637 miles, for August 4378 miles, for September 4869 miles. What was the total wind movement for the three months? What was the average

wind movement per day for each month? For the entire time? What was the average wind movement per hour for the different months? For the entire time?

4. The Santa Fé trail is about 775 miles in length; the Oregon trail is 1048 miles. How much longer is the Oregon trail than the Santa Fé trail?

5. What is the total weight of a carload of 24 steers, if they average 1296 pounds?

6. At a waterworks station two large pumps and four small ones were pumping. The large pumps delivered 1600 gallons each per minute, and the small ones 400 gallons each per minute. How many gallons were pumped per hour?

7. A man earns \$75 per month and his expenses average \$57 per month. How much will he save per year?

8. In order to produce a ton of clover hay, about 375 tons of water are necessary. How many tons will be used in producing 27 tons of clover hay?

9. A wagon weighs 1700 pounds. The wagon loaded with coal weighs 1800 pounds more than twice as much as the wagon. What was the weight of the coal?

10. It takes 16 hours to coal a battleship. How many tons will it hold if it is loaded at the rate of 163 tons per hour?

11. If it costs \$1.90 per ton to mine soft coal and ship it to market, what will a carload of 43 tons cost, allowing a profit of 42 cents per ton to the mine owner?

12. If the coal is sold at retail at \$5 per ton, what is the profit to the dealer for handling the coal in problem 11?

13. If a farmer sold a quantity of wheat for \$988.20, how many bushels did he sell if he received 90 cents per bushel?

14. If hogs are selling at \$7.45 per cwt., what is a 300-pound hog worth? How much will a load of hogs bring if the total weight of the hogs and wagon is 4297 pounds and the wagon weighs 1541 pounds?

15. If there are 12 hogs in the load, what is their average weight? Their average selling price?

16. During 1913, 1,197,892 foreign immigrants came to the United States. What was the average number per month? Per day?

17. In Allen county, Kansas, 896 acres of potatoes in 1910 produced 68,888 bushels, valued at \$55,910.40. What was the average yield per acre? The average value?

18. How many pounds are there in a bushel of shelled corn if 32 bushels weigh 1792 pounds?

19. A balloon will lift a weight of 1000 pounds. How many men, averaging 160 pounds, will be required to hold the balloon down?



## COMMON FRACTIONS

### Study Exercise

**33.** A **fraction** is an indicated division.

The dividend, or the number above the line, is called the **numerator**; the divisor, or the number below the line, is called the **denominator**.

The numerator and the denominator are called the **terms of a fraction**.

If a fraction is less than unity, it is called a **proper fraction**; if it is equal to or greater than unity, it is called an **improper fraction**.

The form of a fraction may be changed without altering its value by reducing the fraction to higher terms or lower terms.

### REDUCING TO LOWER TERMS

**34.** To reduce a fraction to its lowest terms divide the numerator and denominator by the same number; continue to divide by common factors until both terms are prime.

1. Reduce  $\frac{222}{246}$  to lowest terms.

Process

$$\begin{array}{l} 2 \overline{) \frac{222}{246}} = \frac{111}{123} \\ 3 \overline{) \frac{111}{123}} = \frac{37}{41} \quad \text{Ans.} \end{array}$$

**Oral and Written Exercise**

2. Reduce  $\frac{9}{12}$ ;  $\frac{27}{54}$ ;  $\frac{16}{72}$ ;  $\frac{13}{39}$ ;  $\frac{18}{62}$  to their lowest terms.

3. Reduce  $\frac{19}{57}$ ;  $\frac{16}{124}$ ;  $\frac{45}{135}$ ;  $\frac{75}{255}$ ;  $\frac{536}{864}$  to their lowest terms.

4. Reduce  $\frac{42}{98}$ ;  $\frac{81}{123}$ ;  $\frac{64}{96}$ ;  $\frac{144}{1728}$  to lowest terms.

5. Reduce  $\frac{125}{450}$ ;  $\frac{125}{885}$ ;  $\frac{126}{728}$ ;  $\frac{91}{221}$  to lowest terms.

**CHANGING TO HIGHER TERMS**

35. To change a fraction to higher terms, multiply both numerator and denominator by a number that will give the denominator desired.

1. Change or reduce  $\frac{4}{5}$  to 35ths.

**Process**

$$35 \div 5 = 7.$$

$$\frac{4 \times 7}{5 \times 7} = \frac{28}{35}. \text{ Ans.}$$

2. Change  $\frac{1}{2}$ ;  $\frac{3}{4}$ ;  $\frac{5}{8}$  to 16ths.

3. Change  $\frac{5}{9}$ ;  $\frac{2}{3}$ ;  $\frac{1}{2}$ ;  $\frac{5}{6}$  to 18ths.

4. Change  $\frac{1}{2}$ ;  $\frac{3}{4}$ ;  $\frac{2}{3}$ ;  $\frac{1}{6}$ ;  $\frac{5}{8}$ ;  $\frac{5}{12}$  to 24ths.

5. Change  $\frac{1}{2}$ ;  $\frac{3}{4}$ ;  $\frac{3}{8}$ ;  $\frac{5}{16}$  to 32ds.

6. Change  $\frac{5}{6}$ ;  $\frac{5}{18}$ ;  $\frac{7}{9}$ ;  $\frac{3}{4}$ ;  $\frac{2}{3}$ ;  $\frac{1}{2}$ ;  $\frac{7}{12}$  to 36ths.

7. Change  $\frac{1}{2}$ ;  $\frac{1}{4}$ ;  $\frac{3}{5}$ ;  $\frac{7}{8}$ ;  $\frac{7}{10}$ ;  $\frac{3}{20}$  to 40ths.

### CHANGING IMPROPER FRACTIONS TO WHOLE OR MIXED NUMBERS

**36.** To change an improper fraction to a whole or mixed number, divide the numerator by the denominator.

1. Reduce  $\frac{71}{6}$  to a whole or mixed number.

**Process**

$$\frac{71}{6} = 71 \div 6 = 11\frac{5}{6}. \text{ Ans.}$$

2. Reduce  $\frac{87}{5}$ ;  $\frac{657}{13}$ ;  $\frac{126}{17}$ ;  $\frac{283}{27}$  to whole or mixed numbers.

3. Reduce  $\frac{121}{19}$ ;  $\frac{375}{15}$ ;  $\frac{287}{19}$ ;  $\frac{250}{24}$  to whole or mixed numbers.

4. Change  $\frac{234}{9}$  lb.;  $\frac{178}{13}$  pk.;  $\frac{547}{23}$  miles;  $\frac{232}{60}$  hr. to mixed numbers.

5. Change  $\frac{234}{32}$  bu.;  $\frac{252}{12}$  yr.;  $\frac{632}{24}$  da. to mixed numbers.

6. Change  $\frac{1080}{8}$  pk.;  $\frac{5280}{16}$  lb.;  $\$ \frac{896}{25}$ ;  $\$ \frac{762}{50}$  to mixed numbers.

### CHANGING MIXED NUMBERS TO IMPROPER FRACTIONS

**37.** To change a mixed number to an improper fraction, multiply the whole number by the denominator of the fraction, add in the numerator, and write the sum over the given denominator.

1. Reduce  $5\frac{2}{7}$  to an improper fraction.

**Process**

$$5\frac{2}{7}$$

$$\frac{7}{35}$$

$$\frac{2}{37}$$

$$37, \text{ that is, } 5\frac{2}{7} = \frac{37}{7}. \text{ Ans.}$$

2. Reduce  $26\frac{1}{2}$ ;  $47\frac{3}{4}$ ;  $67\frac{5}{9}$ ;  $32\frac{5}{6}$  to improper fractions.

3. Reduce  $55\frac{5}{8}$ ;  $39\frac{6}{11}$ ;  $257\frac{3}{13}$ ;  $394\frac{7}{16}$  to improper fractions.

4. Change  $17\frac{8}{9}$  to ninths;  $48\frac{5}{7}$  to sevenths.

5. Reduce  $579\frac{6}{13}$ ;  $487\frac{5}{17}$ ;  $384\frac{2}{18}$  to improper fractions.

6. Reduce  $1235\frac{4}{19}$ ;  $527\frac{5}{16}$ ;  $7854\frac{3}{11}$  to improper fractions.

7. Reduce  $2721\frac{1}{4}$ ;  $301\frac{1}{4}$ ;  $89\frac{7}{16}$ ;  $266\frac{2}{3}$  to improper fractions.

## ADDITION AND SUBTRACTION OF FRACTIONS

### Least Common Multiple

**38.** The large number of fractions we meet in ordinary work can easily be reduced to a common denominator by inspection, but if the denominators are not easily reducible the following method is very convenient for finding the least common multiple.

1. Add  $\frac{7}{12}$ ,  $\frac{4}{15}$ , and  $\frac{5}{24}$ .

**Process**

$$\begin{array}{r} 2) 12 \quad 15 \quad 24 \\ 2) 6 \quad 15 \quad 12 \\ 3) 3 \quad 15 \quad 6 \\ \hline 1 \quad 5 \quad 2 \end{array}$$

$$2 \times 2 \times 3 \times 5 \times 2 = 120, \text{ l. c. m.}$$

$$\frac{7}{12} = \frac{70}{120}$$

$$\frac{4}{15} = \frac{32}{120}$$

$$\frac{5}{24} = \frac{25}{120}$$

$$\frac{127}{120} = 1\frac{7}{120}. \text{ Ans.}$$

**Explanation:** The denominators are 12, 15, and 24.

Arrange them as here shown.

Divide by any prime number that will go evenly into any two or more of them, bringing down any numbers not divisible.

Repeat this until no two of the numbers have a common divisor.

The product of the divisors and all the numbers remaining will be the least common multiple.

Reduce the fractions to fractions having the common denominator 120.

Add the fractions.

Reduce the improper fraction to a mixed number.

In subtraction of fractions follow the same plan as in addition, and then subtract the numerators.

2. From  $\frac{7}{8}$  take  $\frac{2}{5}$ .

**Process**

$$\frac{7}{8} = \frac{35}{40}$$

$$\frac{2}{5} = \frac{16}{40}$$

$$\frac{7}{8} - \frac{2}{5} = \frac{35}{40} - \frac{16}{40} = \frac{19}{40}. \text{ Ans.}$$

*Addition and Subtraction of Fractions.*—To add or subtract fractions, reduce the fractions to a common denominator and add or subtract the numerators.

**Written Exercise**

**39.** Perform the operations indicated :

1.  $\frac{1}{2} + \frac{2}{3} + \frac{3}{4}$ .
2.  $\frac{5}{6} + \frac{7}{8} + \frac{8}{9} + \frac{1}{3}$ .
3.  $\frac{7}{8} + \frac{1}{6} + \frac{3}{4} + \frac{2}{3}$ .
4.  $\frac{8}{9} - \frac{2}{3} = ?$
5.  $24\frac{1}{2}$  bushels minus  $15\frac{5}{8}$  bushels = ?
6. From  $\frac{8}{9}$  take  $\frac{7}{11}$ ; from  $\frac{11}{12}$  take  $\frac{9}{10}$ .
7. From  $17\frac{1}{7}$  take  $8\frac{1}{8}$ ; from  $19\frac{2}{7}$  take  $13\frac{5}{8}$ .
8. From  $41\frac{1}{5}$  take  $39\frac{5}{6}$ ; from  $34\frac{1}{2}$  miles take  $19\frac{3}{4}$  miles.
9.  $\frac{2}{3} + \frac{5}{7} - \frac{5}{9} + \frac{3}{14}$ .
10.  $\frac{7}{8} - \frac{1}{6} + \frac{3}{5} - \frac{3}{10}$ .

**Written Problems**

40. 1. From a car of  $40\frac{1}{2}$  tons of coal,  $29\frac{3}{4}$  tons were sold. How many tons remained?
2. From  $33\frac{1}{3}$  yards of cloth,  $12\frac{1}{4}$  yards and  $7\frac{1}{2}$  yards were sold. How many yards were left?
3. A bin contained  $354\frac{1}{2}$  bushels of wheat, from which  $216\frac{2}{3}$  were sold and  $29\frac{1}{2}$  were sowed. How many bushels were left in the bin?
4. If cream contains  $\frac{3}{100}$  protein,  $\frac{13}{50}$  fat,  $\frac{7}{250}$  carbohydrates,  $\frac{9}{500}$  salts, and the rest water, find the amount of water.
5. If wheat bread contains  $\frac{2}{25}$  protein,  $\frac{3}{200}$  fat,  $\frac{1}{2}$  carbohydrates,  $\frac{13}{1000}$  salts, and the rest water, find the amount of water.

6. If a man devotes  $\frac{7}{24}$  of his time to sleep,  $\frac{1}{12}$  to meals,  $\frac{3}{8}$  to business, how much of his time is left for other purposes?

7. After an automobile had been driven  $48\frac{1}{4}$  miles,  $50\frac{2}{5}$  miles, and  $40\frac{3}{4}$  miles, the speedometer read  $455\frac{4}{5}$  miles. What was the reading at the start?

## MULTIPLICATION AND DIVISION OF FRACTIONS

### Study Exercise

41. In multiplication of fractions multiply the numerators together for a new numerator, and the denominators together for a new denominator. Reduce the resulting fraction to its lowest terms. Employ cancellation whenever possible. In division invert the divisor and proceed as in multiplication.

An indicated division in which one or both terms are fractions is called a complex fraction.

In multiplication of fractions do not multiply the terms until all the like factors have been canceled.

1. Multiply  $\frac{7}{8}$  by  $\frac{6}{7}$ .

#### Process

$$\begin{array}{c} 7 \\ 8 \\ 4 \end{array} \times \begin{array}{c} 3 \\ 6 \\ 7 \end{array} = \frac{3}{4} \text{ Ans.}$$

2. Multiply  $4\frac{2}{5}$  by  $5\frac{5}{7}$ .

**Process**

$$4\frac{2}{5} \times 5\frac{5}{7} = \frac{22}{5} \times \frac{40}{7} = \frac{176}{7} = 25\frac{1}{7}. \text{ Ans.}$$

In division invert the divisor and proceed as in multiplication.

3. Divide  $\frac{8}{9}$  by  $\frac{2}{3}$ .

**Process**

$$\frac{8}{9} \div \frac{2}{3} = \frac{8}{9} \times \frac{3}{2} = \frac{4}{3}. \text{ Ans.}$$

4. Divide  $6\frac{1}{8}$  by  $2\frac{4}{5}$ .

**Process**

$$6\frac{1}{8} \div 2\frac{4}{5} = \frac{49}{8} \div \frac{14}{5} = \frac{49}{8} \times \frac{5}{14} = \frac{35}{16} = 2\frac{3}{16}. \text{ Ans.}$$

### Written Exercise

- 42.** Perform the operations indicated :

1. Multiply  $\frac{5}{6}$  by 7 ;  $\frac{7}{10}$  by 4 ;  $\frac{6}{7}$  by 9.
2. Multiply  $\frac{5}{8}$  by  $\frac{7}{9}$  ;  $\frac{5}{11}$  by  $\frac{3}{8}$  ;  $\frac{8}{9}$  by  $\frac{3}{4}$ .
3. Multiply  $6\frac{5}{8}$  by 8 ;  $17\frac{7}{11}$  by 18 ;  $19\frac{9}{13}$  by  $11\frac{1}{2}$ .
4. Multiply  $24\frac{4}{7}$  by  $\frac{7}{8}$  ;  $18\frac{7}{10}$  by  $\frac{5}{11}$  ;  $4\frac{9}{13}$  by  $11\frac{1}{2}$ .
5. Multiply  $16\frac{7}{9}$  by  $4\frac{2}{3}$  ;  $25\frac{1}{8}$  by  $7\frac{5}{6}$  ;  $47\frac{4}{5}$  by  $9\frac{2}{7}$ .
6. Divide 13 by  $\frac{2}{11}$  ;  $\frac{7}{8}$  by  $\frac{9}{11}$  ;  $\frac{8}{9}$  by  $1\frac{6}{13}$ .



- ### Written Problems

43. 1. If 100 pounds of milk produce  $5\frac{1}{2}$  pounds of butter, how much will a pound of milk produce?
2. With the same production as in problem 1, how much butter will a cow, giving four gallons of milk a day, produce if the milk weighs  $8\frac{3}{5}$  pounds per gallon?
3. A dressed hog weighs 308 pounds which is  $\frac{1}{5}$  of the live weight. What was the live weight?
4. A train running from Baltimore to Cumberland makes the distance of  $192\frac{1}{5}$  miles in  $4\frac{1}{3}$  hours. What is the rate per hour of the train?
5. If a dry gallon contains  $268\frac{4}{5}$  cubic inches, how many cubic inches do  $94\frac{2}{3}$  dry gallons contain?
6. A merchant buys the following bill of goods: cotton goods \$235.70, silk \$361.85, and carpets \$458.50. He receives a discount of  $\frac{1}{5}$  of the bill for cash. What does he pay for the goods?

7. If it requires  $7\frac{1}{5}$  acres of corn to fill a 98-ton silo, what fractional part of the silo will one acre fill?

8. If a normal child at birth has a chest measurement of  $13\frac{1}{2}$  inches and at 4 years of age of  $20\frac{3}{4}$  inches, what is the average yearly increase in chest measurement?

9. If a man working  $7\frac{1}{2}$  hours a day can complete a piece of work in  $16\frac{2}{3}$  days, how many hours must he work per day in order to complete the same work in  $14\frac{1}{2}$  days, working at the same rate?

10. If a loom weaves 60 yards of cloth in  $12\frac{1}{2}$  hours, how many yards are woven in an hour? How long will it take to weave 165 yards?

### Review Written Exercise

44. 1.  $\frac{2}{9} + \frac{2}{3} + \frac{3}{5} + \frac{2}{7} = ?$

2.  $6\frac{2}{3} + 2\frac{3}{7} + 4\frac{3}{14} + 8\frac{3}{4} = ?$

3.  $25\frac{3}{8} + 16\frac{2}{3} - 12\frac{2}{9} = ?$

4.  $75\frac{1}{2} + 57\frac{2}{5} - 46\frac{1}{4} - 21\frac{1}{5} = ?$

5.  $\frac{4}{9} \times \frac{3}{16} \times \frac{1}{8} \times \frac{7}{9} = ?$

6.  $5\frac{3}{5} \times 3\frac{3}{4} \times 7\frac{1}{8} = ?$

7.  $150\frac{3}{4} \div 22\frac{1}{3} = ?$

8.  $70\frac{1}{5} \times 33\frac{1}{3} \times 24\frac{3}{8} = ?$

9.  $\frac{\frac{3}{5} + \frac{4}{7}}{3\frac{1}{3} + 2\frac{1}{4}}$

10.  $\frac{4\frac{1}{6} - 2\frac{1}{3}}{8\frac{1}{4} - 3\frac{2}{3}}$

**Review Written Problems**

45. 1. A bank teller received during the day \$3285 in silver and paper money. There was  $\frac{2}{3}$  as much silver as paper money. How much of each did he receive?

2. A merchant bought  $37\frac{1}{2}$  pounds of coffee for \$14.25; if he had paid  $2\frac{3}{8}\%$  less a pound, how many pounds would he have received?

3. If a farm is  $\frac{4}{15}$  in corn,  $\frac{3}{20}$  in wheat,  $\frac{1}{8}$  in oats,  $\frac{1}{5}$  in pasture,  $\frac{7}{40}$  in timber, and the remaining  $6\frac{2}{3}$  acres is occupied by buildings, yards, etc., what is the size of the farm, and how many acres are in each division?

4. A farmer mixed a ton of fertilizer for his corn land, using  $\frac{2}{5}$  cottonseed meal at \$30.50 a ton and  $\frac{1}{20}$  and  $\frac{1}{20}$  of the rest acid phosphate and muriate of potash respectively. The acid phosphate cost \$15.25 a ton and the potash \$45.50 a ton. What did the fertilizer cost?

5. Three pipes can empty a reservoir in  $5\frac{1}{3}$ , 4, and  $3\frac{3}{4}$  hours respectively. How long will it take them running together?

6. If a man by working  $5\frac{1}{2}$  hours a day can complete a piece of work in  $9\frac{1}{3}$  days, how many hours must he work per day to complete the work in 7 days?

7. If it requires  $4\frac{3}{8}$  acres of corn to fill a 65-ton silo, how many acres will it require to fill a 90-ton silo?

8. If one cow requires 31 cents worth of feed to produce  $1\frac{1}{2}$  pounds of butter fat and a second cow produces 1 pound for  $16\frac{1}{2}\text{¢}$ , what fraction of the feed required by the first cow is sufficient for the second?

9. If an apple tree bears 2781 apples and  $\frac{1}{3}$  are windfalls, and  $\frac{1}{5}$  of the remaining are wormy, what fraction of the apples is good? What is the number of good apples?

10. A farmer bought  $15\frac{1}{2}$  bushels of clover seed containing  $\frac{3}{4}$  bushel of poor seed for \$8.25 per bushel. What was the total cost of the seed? How much per bushel for the good seed?

11. A merchant bought 250 baskets of peaches at  $37\frac{1}{2}\text{¢}$  a basket. He sold  $\frac{1}{5}$  of them at an advance of 10 ¢ a basket,  $\frac{3}{10}$  of the remainder at 35 ¢ a basket, and the remainder at a loss of  $5\frac{1}{2}\text{¢}$  a basket. What did he gain or lose?

12. If  $\frac{4}{7}$  of the value of a farm is \$4360, what is  $\frac{1}{8}$  of the farm worth? If  $\frac{4}{7}$  and  $\frac{1}{8}$  of the farm are deeded to heirs, what is the value of the part remaining?

## DECIMAL FRACTIONS

### Study Exercise

**46. A decimal fraction** is a fraction whose denominator is ten or a multiple of ten.

The denominator is usually not written, but the denomination is indicated by the position of the decimal point. Thus:  $\frac{9}{10} = .9$ ;  $\frac{9}{100} = .09$ .

The **decimal point** separates the whole number from the fraction. Thus: 2.57; 76.039.

The first place to the right is **tenths**; the second, **hundredths**; and the third, **thousandths**, etc.

A **pure decimal** is one containing neither a whole number nor a common fraction; as, .587.

A **mixed decimal** is one containing a whole number and a decimal; as, 76.39.

A **complex decimal** is one which ends with a common fraction; as,  $.57\frac{1}{4}$ .

Fundamental principles involved in decimals:

(1) **If the decimal point is moved to the right, the number is multiplied by 10 for each place the point is moved.**

Thus:  $.765 \times 10 = 7.65$ .

(2) **If the decimal point is moved to the left, the number is divided by 10 once for each place the point is moved.**

Thus:  $.765 \div 10 = .0765$ .

**Oral Exercise**

47. Read the following :

- |               |                             |              |
|---------------|-----------------------------|--------------|
| 1. .6.        | 5. .5365.                   | 9. 1.001.    |
| 2. .53.       | 6. .206.                    | 10. 10.10.   |
| 3. .325.      | 7. 12.12.                   | 11. 43.0043. |
| 4. .03.       | 8. 205.205.                 | 12. 808.08.  |
| 13. 57.00057. | 16. 72.0001.                |              |
| 14. .000789.  | 17. 8.00998 $\frac{1}{7}$ . |              |
| 15. 7007.707. | 18. 26,000.00026.           |              |

**COMMON AND DECIMAL FRACTIONS**

48. Common fractions may be reduced to decimals, and decimals to common fractions.

To reduce a common fraction to a decimal, annex ciphers to the numerator and divide by the denominator.

1. Reduce  $\frac{1}{8}$  to a decimal.

**Process**

$$\frac{1}{8} \times \frac{125}{125} = \frac{125}{1000} = .125 \text{ Ans. or } 8 \overline{)1.000} \quad \underline{.125} \text{ Ans.}$$

To reduce a decimal to a common fraction, write the fraction with its denominator and reduce it to its lowest terms.

2. Reduce .375 to a common fraction.

**Process**

$$.375 = \frac{375}{1000} = \frac{3}{8} \text{ Ans.}$$

**Written Exercise**

49. 1. Reduce .25; .75; .625; .875; .275 to common fractions.

2. Reduce  $.33\frac{1}{3}$ ;  $.66\frac{2}{3}$ ;  $.83\frac{1}{3}$ ;  $.16\frac{2}{3}$  to common fractions.

3. Reduce 5.875; 32.0225; 5.625; 75.015; 300.05;  $210.3\frac{1}{3}$  to common fractions.

4. Reduce  $\frac{5}{8}$ ;  $\frac{2}{5}$ ;  $\frac{3}{4}$ ;  $\frac{5}{6}$ ;  $\frac{1}{8}$ ; and  $\frac{1}{32}$  to decimals.

5. Reduce  $\frac{2}{3}$ ;  $\frac{7}{12}$ ;  $\frac{5}{32}$ ;  $\frac{5}{16}$ ; and  $\frac{4}{26}$  to decimals.

6. Reduce  $\frac{5}{13}$ ;  $\frac{7}{18}$ ;  $\frac{7}{9}$ ;  $\frac{5}{14}$ ; and  $\frac{5}{21}$  to decimals.

7. Reduce  $6\frac{7}{8}$ ;  $16\frac{1}{4}$ ;  $98\frac{4}{7}$ ;  $7\frac{1}{3}$ ;  $5\frac{3}{16}$  to mixed decimals.

**ADDITION AND SUBTRACTION OF DECIMALS**

50. Since the units, tens, etc., are to the left of the decimal point, and the tenths, hundredths, etc., are to the right of the decimal point, it follows that to add decimals the numbers must be written so that the decimal points lie in a vertical line; i.e., so that the different denominations come in the same column. The addition should be performed as in addition of whole numbers. The same rule as regards the decimal point also applies to subtraction.

Add 25.2; 32.07; 56.255; 125.0125; 7.8; and 34.65.

**Process**

25.2  
 32.07  
 56.255  
 125.0125  
 7.8  
 34.65

280.9875 *Ans.*

**Explanation:** Arrange the addends in form for addition, keeping the decimal points in vertical line, so as to keep units under units, tens under tens, etc. Add.

**Written Exercise**

**51.** Perform the operations indicated. Check the results:

1. Add 6.789; 1.067; .024; .65; 17.005; .0046; 1.035; 1.0706; 24.018.

2. From 234.096 take 74.16; from 13.435 take .306; from 41 take 35.067.

3. From .9 take .0652; from 765.789 take 34.908.

4. From 1001.0897 take 8.0907; from .235 take .0007.

5. From 6000.0873 take 754.0001; from 21.3004 take 17.017.

6. From \$154.75 take \$19.48; from \$1010.20 take \$524.38.

7. From 707.413 take 90.00019; from 17.00017 take 8.378.

8. From ten thousand ten and one hundred one thousandths take nine hundred nine and nineteen hundred-thousandths.



9. From 503.458 take 189.0009; from 784.009 take 229.0009.

10. From \$1235.65 take \$825.35; from \$3727.84 take \$1779.87.

11. From three thousand three and seven hundred sixty-five thousandths take two thousand one and seventy-seven ten-thousandths.

$$12. .5007 + .7068 + .70007 + 406.1295 + 46.008 - 86.1745 - .005274 = ?$$

$$13. 3.8 + 743.65 + .08 + .00306 + .863 + 14.7436 = ?$$

$$14. 7.63427 + 8.0907 - 2.054 + .0601 + 24.018 = ?$$

$$15. 72.6\frac{1}{4} + 23.56\frac{1}{3} + 18.37\frac{1}{2} - 29.6\frac{2}{3} = ?$$

$$16. 83.31\frac{1}{4} + 32.768\frac{2}{3} + 40.12\frac{1}{2} - 61.17\frac{3}{4} = ?$$

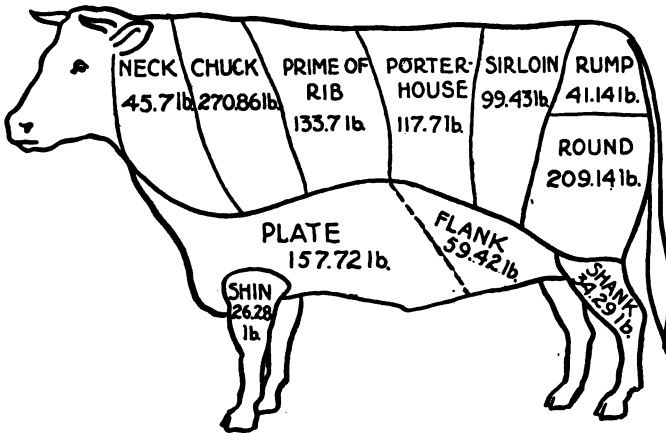
$$17. 69.17\frac{1}{2} - 38.16\frac{2}{3} - 20.8\frac{1}{3} + 12.06\frac{3}{8} = ?$$

$$18. 78.04\frac{1}{8} + 97.40\frac{1}{8} - 37.78\frac{5}{8} - 26.16\frac{1}{3} = ?$$

$$19. 3.015\frac{2}{5} + .86\frac{4}{9} + .007\frac{2}{9} + .78\frac{1}{2} + .0085\frac{3}{5} + 2.8\frac{5}{8} + .9\frac{3}{7} = ?$$

### Written Problems

52. 1. The rainfall at Geneva, N. Y., for 1913, from January to December inclusive, was as follows: 3.88 in.; .11 in.; 4.6 in.; 3.40 in.; 2.68 in.; 3.24 in.; 2.03 in.; 1.65 in.; 2.64 in.; 4.03 in.; 2.41 in.; .77 in. What was the total rainfall?



2. The above illustration shows butcher's cuts and their relative weights. The live weight of the animal was 1733; the dressed weight of the carcass is how many pounds? What is the value at the following prices: neck,  $12\frac{1}{2}\phi$ ; chuck,  $15\phi$ ; prime of rib,  $15\phi$ ; porterhouse,  $22\frac{1}{2}\phi$ ; sirloin,  $22\frac{1}{2}\phi$ ; rump,  $15\phi$ ; round,  $20\phi$ ; plate,  $10\phi$ ; flank,  $15\phi$ ; shank,  $8\phi$ ; and shin,  $8\phi$ ?

3. The labor expenses in producing an acre of corn were: shelling seed, \$.03; plowing, \$1.31; dragging, \$.54; planting, \$.24; cultivating, \$1.81; husking, \$3.46. What was the total expense?

4. A chemical analysis of a package of butter weighing 16.7 ounces showed 13.8 ounces of fat, .15 ounce of casein, .46 ounce of salt, and the rest water. What was the amount of water?

5. If in 100 pounds of alfalfa meal there are 9.1 pounds of water, 9.5 pounds of ash, 26.6 pounds of fiber, 36.8 pounds of nitrogen, 2.1 pounds of fat, and the rest protein, how much protein is there ?

### MULTIPLICATION AND DIVISION OF DECIMALS

**53.** In multiplication of decimals proceed as in whole numbers, and then point off as many places in the product as there are places in both the multiplier and multiplicand.

In division, after dividing as in whole numbers, point off as many places in the quotient as the number of places in the dividend exceeds the number in the divisor. If there are fewer places in the dividend than in the divisor, add a sufficient number of ciphers to make the number of places the same.

Simplify the process by making the divisor a whole number.

1. Divide 43.051 by .314.

#### Process

$$\begin{array}{r}
 137.10 \\
 \underline{.314 \overline{) 43.051.00}} \\
 314 \phantom{00} \\
 \underline{1165} \phantom{00} \\
 942 \phantom{00} \\
 \underline{2231} \phantom{00} \\
 2198 \phantom{00} \\
 \underline{330} \phantom{00} \\
 314 \phantom{00} \\
 \underline{160}
 \end{array}$$

**Explanation:** Change the decimal divisor to a whole number by moving the point three places to the right. Move the point in the dividend to the right the same number of places. Cross out the old points. Divide.

**Written Exercise**

**54.** Perform the operations indicated. Check the results.

1. Multiply 246.324 by .172.
2. Multiply .00086 by 45.3.
3. Multiply 324.547 by 7.32; 789.67 by 394.835.
4. Multiply 70.08754 by 6.875; .0656 by 4.2.
5. Multiply 54.785 by .002; 765.53 by .0634.
6. Divide 25.25 by .25; 73.731 by .0003.
7. Divide .000875 by 125; .0101 by 101.
8. Divide 3243 by .0001; 742.303 by .6.
9. Multiply 1.017 by 1.2; 4235.5 by 562.74.
10. Divide 2.4 by .0008; 523.546 by 4325.08.
11. Multiply 117.11 by 31.01; 690.007 by 9.004; .7854 by 36.
12. Multiply 3.1416 by 38.62; 2.7818 by .7447; 6069.06 by .00346.
13. Multiply  $15.37\frac{1}{2}$  by  $21.08\frac{1}{3}$ ;  $28.72\frac{3}{4}$  by  $45.66\frac{2}{3}$ ;  $.19.6\frac{2}{3}$  by  $.037\frac{1}{4}$ .
14. Divide  $125.42\frac{1}{3}$  by  $26.6\frac{1}{4}$ ;  $86.16\frac{1}{6}$  by  $12.17\frac{1}{2}$ ;  $92.28\frac{3}{4}$  by  $5.83\frac{1}{3}$ .

**Written Problems**

**55.** 1. What will 15,850 bricks cost at \$ 6.75 per thousand?

2. What will 5484 feet of lumber cost at \$ 4.25 per thousand feet?

3. What will 2750 pounds of hay cost at \$ 14.50 per ton?
4. What is a load of 4110 pounds of coal worth at \$ 4.50 per ton?
5. What is the value of 38 barrels of apples at \$ 4.50 per barrel?
6. What is 7463 pounds of corn worth at 95¢ a hundred.
7. One bushel of wheat occupies about .8 of a cubic foot of space. How many bushels in a bin that contains 478.75 cubic feet?
8. Find the cost of 3125 pounds of corn meal at \$ 3.15 a hundred.
9. What is the freight on a bill of goods weighing 3185 pounds at 85¢ a hundred?
10. A load of wheat weighs 1875 pounds net. What is its value at \$ 1.12 a bushel?

#### ALIQUOT PARTS APPLIED TO MULTIPLICATION AND DIVISION

56. An aliquot part is a simple fractional part of 100. Those most commonly used are: 50, or  $\frac{1}{2}$  of 100; 25, or  $\frac{1}{4}$  of 100;  $33\frac{1}{3}$ , or  $\frac{1}{3}$  of 100; 10 or  $\frac{1}{10}$  of 100;  $8\frac{1}{3}$ , or  $\frac{1}{12}$  of 100;  $6\frac{1}{4}$ , or  $\frac{1}{6}$  of 100.

1.  $14\frac{2}{7}$  is what part of 100?
2. 40 is what part of 100?
3. 75 is what part of 100?
4. 60 is what part of 100?

5. 80 is what part of 100 ?
6.  $37\frac{1}{2}$  is what part of 100 ?
7.  $31\frac{1}{4}$  is what part of 100 ?
8.  $62\frac{1}{2}$  is what part of 100 ?
9.  $87\frac{1}{2}$  is what part of 100 ?
10.  $66\frac{2}{3}$  is what part of 100 ?
11.  $41\frac{2}{3}$  is what part of 100 ?
12.  $83\frac{1}{3}$  is what part of 100 ?
13.  $58\frac{1}{3}$  is what part of 100 ?
14. 125 is what part of 100 ?
15. 150 is what part of 100 ?
16. 175 is what part of 100 ?

57. To multiply a number by any one of the aliquot parts, first multiply by 100 by annexing two ciphers, then by the fractional part the number is of 100.

1. Multiply 480 by 25.

<p><b>Process</b></p> $\frac{480 \times 100}{4} = 12,000$	<p><b>Explanation:</b> To multiply by 25, first multiply by 100, and since 25 is <math>\frac{1}{4}</math> of 100 take <math>\frac{1}{4}</math> of the product. In this process, do not cancel 4 into 100.</p>
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To divide a number by an aliquot part, first divide the number by 100 and then, since the quotient is the result of dividing by a number that is larger than the number to be used as a divisor, multiply the result by the fractional part (inverted) the divisor is of 100.

## 2. Divide 480 by 25.

**Process**                      **Explanation:** To divide a number by 25, first divide the number by 100. Now, since the divisor is 4 times as great as 25, the result will only be  $\frac{1}{4}$  as much as it should be; hence, multiply by four to obtain the result required.

$$\frac{480 \times 4}{100} = 19.$$
**Written Exercise**

**58.** Perform the operations indicated, using the aliquot parts method when possible.

1. Multiply and divide 936, 876, 3647, 1357, 4321 by  $12\frac{1}{2}$ ,  $16\frac{2}{3}$ ,  $33\frac{1}{3}$ .
2. 35 is what part of 95?
3. 17 is what part of 68?
4.  $22\frac{1}{2}$  is what part of 80?
5.  $32\frac{1}{4}$  is what part of 120?
6.  $16\frac{2}{3}$  is what part of  $37\frac{1}{2}$ ?
7.  $67\frac{1}{2}$  is what part of 150?
8.  $41\frac{3}{4}$  is what part of  $60\frac{1}{3}$ ?
9.  $78\frac{1}{3}$  is what part of  $96\frac{2}{3}$ ?
10.  $50\frac{5}{8}$  is what part of  $75\frac{3}{4}$ ?

**Written Problems**

- 59.** 1. What are 18 pounds of coffee worth at 25 ¢, at  $33\frac{1}{3}$  ¢, at  $37\frac{1}{2}$  ¢, per pound?
2. What will 96 rods of wire fence cost at  $66\frac{2}{3}$  ¢ per rod?
3. What rent will a man pay for a section of land at \$  $6\frac{1}{4}$  per acre?

4. What will be received for a 40-gallon can of milk at  $8\frac{1}{3}$ ¢ per quart?
5. A drover paid \$ 825 for cattle at \$ 37.50 a head. How many did he buy?
6. What is the value of 42 cars of coal averaging  $37\frac{1}{2}$  tons each at \$  $3.87\frac{1}{2}$  a ton?
7. Find the cost of 795 miles of railroad at \$ 6250 a mile.
8. How many pounds of fertilizer at \$. $83\frac{1}{3}$  per hundredweight can be bought for \$ 15.50?
9. How many feet of lumber at \$ 31.25 per M can be bought for \$ 165?

### REVIEW OF DECIMALS AND COMMON FRACTIONS

#### Written Exercise

60. The following table shows the effect of continuous cropping, with and without manuring.

(From the Rothamsted, Hertfordshire, England.)

YEAR	BUSHEL OF WHEAT PER ACRE		BUSHEL OF BARLEY PER ACRE	
	Unmanured	Manured	Unmanured	Manured
1844-'51 . . . . .	$17\frac{3}{4}$	28	—	—
1852-'59 . . . . .	$16\frac{1}{8}$	$34\frac{3}{4}$	$24\frac{1}{4}$	$44\frac{1}{4}$
1860-'67 . . . . .	$13\frac{1}{2}$	$35\frac{3}{4}$	18	$32\frac{3}{4}$
1868-'75 . . . . .	$12\frac{1}{4}$	$35\frac{3}{4}$	$14\frac{5}{8}$	$49\frac{1}{2}$
1876-'83 . . . . .	$10\frac{1}{2}$	$28\frac{5}{8}$	$14^1$	$52\frac{1}{4}$
1884-'91 . . . . .	$12\frac{3}{4}$	$39\frac{1}{4}$	$11\frac{3}{4}$	$44\frac{5}{8}$
1892-'93 . . . . .	$9\frac{1}{2}$	$33\frac{3}{4}$	$10\frac{3}{4}$	$49\frac{1}{2}$



1. What was the total yield of wheat on the unmanured field? The total barley yield?
2. What was the total yield of wheat on the manured field? The total yield of barley?
3. Determine the average yield per year for each of the columns given above.

### Written Problems

- 61.** 1. If the average yield of wheat in Kansas is 13.7 bushels, what is the value of the wheat at 95¢ per bushel?
2. If it costs \$9.34 to produce an acre of wheat, what is the average profit to the wheat grower in Kansas? If the average were increased to 31 bushels (the average for Great Britain), what would be the profit in raising wheat in Kansas?
3. If .025 of the seed wheat used to sow an 80-acre field, five pecks to the acre, was weed seed, how many pecks of the seed were weed seed? How many acres were sowed to weeds?
4. If alfalfa seed is \$9 per bushel, what is the price per bushel for pure seed if .23 of the seed is weed seed?
5. If clover seed is \$7.50 per bushel and .17 of the seed is weed seed, and a germination test showed that 2 out of every 25 of the pure seed will not germinate, what is the cost per bushel for good seed?

6. A man's time is worth 30¢ per hour. What is it worth to treat 150 bushels of wheat with a solution for killing smut spores, if 20 bushels of seed can be treated in an hour?

7. If a farmer pays \$ 3 for a smut cure treatment, and if the yield on 120 acres of wheat is increased 6 bushels per acre thereby, what is his increased profit per acre if wheat is worth 95¢ per bushel?

8. The mixture to kill smut spores in wheat costs 50¢ for 40 bushels. If  $1\frac{1}{4}$  bushels of wheat are sown to the acre, what will the solution cost per acre?

9. If it costs \$10.44 per acre to produce a crop of corn and husk it from the standing stalks, what does it cost to produce a bushel of corn when the yield is 60 bushels per acre? 40 bushels per acre? 75 bushels per acre?

10. If it costs \$ 5.50 per acre to produce a crop of 2.5 tons of clover hay, how much does it cost to produce a ton of clover hay?

11. If corn is worth 40¢ a bushel (56 lb.) and clover hay \$ 8 per ton, what will it cost per day to feed a horse 10 pounds of corn and 14 pounds of clover hay?

12. If bran is \$24 a ton, corn 60¢ per bushel, and hay \$ 9 per ton, what will be the cost of a day's feed, consisting of 8 pounds of bran, 6 pounds of corn, and 16 pounds of hay?

13. What will it cost to feed a horse 16 pounds of hay and 5 pounds of oats, if hay is worth \$ 9 per ton and oats are worth 37 ¢ per bushel (45 lb.) ? If the above is the average feed per day for a horse at light work, what will it cost to keep a horse a year ?

14. What is the cost of 12 pounds of corn stover and 10 pounds of hay, if corn stover is \$ 4 per ton and clover hay \$ 9 per ton ?

15. A cow eats 3.5 tons of hay worth \$ 7 per ton, 1200 pounds of ground feed worth 90 ¢ per hundred, and pasture amounting to \$ 8. What will it cost to keep a cow a year ?

16. An ordinary cow will give 13 pounds of milk per day for 300 days in the year. If .042 of the milk is butter fat, what will be the gross receipts from the cow with the butter fat averaging 29 ¢ per pound ?

17. A carefully selected Jersey cow will give 24 pounds of milk per day for 325 days in the year. If .053 of the milk is butter fat, what will be the gross receipts from this cow ? Compare with Problem 16.

18. A sample of fresh milk, tested by the Babcock test, showed that .0364 of the milk was butter fat. After the milk was set away in shallow pans for 12 hours and then skimmed, the test showed that .0044 of the skimmed milk was butter

fat. What fraction of the butter fat was left in the skimmed milk?

19. Another sample of the same milk is set away in deep pans for the same time, and the skimmed milk showed that only .0017 of the milk was butter fat. What fraction of the butter fat was lost?

20. After using a hand separator on another sample of the milk, .0002 of the skimmed milk was butter fat. What fraction of the butter fat was lost?

21. Maid Henry, of the Kansas State Agricultural College, the world's champion fourteen-year-old cow, gave 19,600.4 pounds of milk, of which .0364 was butter fat. What would have been the number of pounds lost if the shallow-pan system of separating the cream had been used? What would have been the value of the butter fat at 29¢ per pound?

22. What would have been the loss if the deep-pan system had been used? What would have been the value of the butter fat at 29 ¢ per pound?

23. What would have been the loss in pounds, and in value at 29 ¢ per pound, if the hand separator had been used?

24. How long would it take to save the price of a \$55 separator if the shallow-pan system were used? If the deep-pan system were used?

25. One hundred pounds of corn contain about 1.58 pounds of nitrogen, .37 pound of potash, and .57 pound of phosphorus. How much of each of these elements does a crop of 50 bushels (70 lb.) remove from the soil?

26. Forty analyses of soils from different parts of the United States showed an average of 3000 pounds of nitrogen, 4000 pounds of phosphorus, and 16,000 pounds of potash per acre. If a crop of 13.8 bushels of wheat removes 14.5 pounds of nitrogen, 10.6 pounds of phosphorus, and 14 pounds of potash from the soil, how many crops of wheat could be produced if all the nitrogen were available? If all the phosphorus were available? If all the potash were available?

27. For every ton of wheat sold from the farm it is estimated that the farmer sells \$ 8.35 worth of fertility, and for every ton of corn \$ 6.50 worth. What is the value of the plant food removed from the soil, if he raises and sells 860 bushels of wheat and 1134 bushels of corn?

28. The Wisconsin Experiment Station bulletin reports that by using 20 tons of manure upon an acre of ground 7420 pounds of hay were produced, by using 10 tons 4350 pounds were produced, and by not using any at all only 2330 pounds were produced. Which acre yielded the greater profit, if the manure is valued at \$1 per ton and hay is worth \$18 per ton?

29. In a block of Ben Davis apple trees at the Kansas State Agricultural College not sprayed, 834 of the 1769 apples produced were affected with the blotch. What fraction of the apples was affected? What decimal fraction?

30. In another block, sprayed with lime and sulphur, 960 of the 3675 produced were affected. What fraction of the apples was affected? What decimal fraction?

31. In another block, sprayed with a 3-4-50 Bordeaux mixture, 2438 apples were produced and 50 were affected with the blotch. What fraction of the apples was affected? What decimal fraction?

32. A person who owned  $\frac{5}{8}$  of a coal mine sold  $\frac{1}{3}$  of his share for \$12,380. What was the entire value of the mine?

33. A farmer exchanged 32 bushels of potatoes @  $67\frac{1}{2}$ ¢ per bushel for sugar at 19 pounds for \$1. How many pounds of sugar did he receive?

34. A man invested  $\frac{3}{8}$  of his money in land,  $\frac{2}{3}$  of the remainder in a house,  $\frac{2}{5}$  of what was then left in bonds, and had \$765 left. How much money had he at first?

35. If the freight from St. Louis to Chicago is 44¢ per hundred pounds, what must be paid on four boxes of goods, weighing respectively 269.4, 365.5, 437.25, and 341.25 pounds?

36. A dealer in Boston retails coal at \$8.25 per ton. If a ton costs \$4.15 at the mine, and the freight is 65¢, what is the dealer's profit on 9260 pounds of coal?

37. A grocer's sales on sugar and coffee on a certain day amounted to \$302.94. He sold the same number of pounds of each, the sugar at 16 pounds for a dollar, and the coffee at 32¢ per pound. How many pounds of each did he sell?

38. A mower costing \$41 and cutting on the average 28 acres a year, will last about 14.8 years. The repair charges are \$26.94 and the interest on the money invested is \$19.39. If actually used 46 days during its life, what is the cost of the mower per day used? per acre cut?

39. A binder costing \$125 and cutting 35.2 acres annually, lasts about 15.4 years. The repair charges are \$31.20 and the interest on the investment is \$61.60. If actually used 53 days during its life, what is the cost of the binder per day used? per acre cut?

40. What will it cost to feed a horse 4 pounds of oats, 6 pounds of corn, 4 pounds of bran, and 12 pounds of hay, if oats are worth 42¢ a bushel, corn, 45¢ a bushel, bran, \$1.15 a hundred, and hay, \$9.50 a ton? If the above is the average amount of feed per day for a horse at heavy work, what will it cost to keep a horse a year?

## FARM ACCOUNTS

### Study Lesson

**62.** Almost every up-to-date farmer finds it necessary to keep accurate accounts of his daily, weekly, monthly, and yearly business transactions. The farmer may feel that he is making some money from year to year, yet unless he keeps accounts he will not know how much, nor just what is the most profitable part of his business. Certain crops he is raising or certain animals he is keeping may yield an actual loss. He may be gaining in some other line so that at the end of the year he feels that there has been a profit, but a greater gain might have resulted if he had discontinued certain activities. The accounts will also be a protection in case of dispute or death.

*Farm Inventory.* No merchant would feel that he knew exactly how his business stood unless he took an inventory of his stock at least every year; the farmer should feel the same. A farm inventory includes the land, stock, machinery, tools, hay, grain, household goods, accounts, cash, debts, and all property belonging to the farmer. In taking an inventory, the actual value of the different items based upon local prices should be used.



**Study Exercise**

**63.** How to arrange and make a farm inventory.

In arranging an inventory all the different items should be carefully enumerated with the estimated value of each and put in the following tabular form :

320	acres of land @ \$75 per acre . . . . .	\$24,000.00
3	horses @ \$225 each . . . . .	675.00
2	horses @ \$175 each . . . . .	350.00
3	horses @ \$150 each . . . . .	450.00
5	milch cows @ \$65 each . . . . .	325.00
25	two-year-old steers @ \$25 each . . . . .	625.00
6	brood sows @ \$25 each . . . . .	150.00
40	sheep @ \$7 each . . . . .	280.00
45	shoats @ \$4 each . . . . .	180.00
200	chickens @ 65c each . . . . .	130.00
600	bushels of corn in the crib @ 60c . . . . .	360.00
	Total resources . . . . .	\$

1. Make out an inventory, itemizing the different assets of your father's farm or some other farm with which you are familiar.

**Study Lesson**

**64.** How to start a farm account book and keep a cash account.

In starting a set of books provide a ruled blank book of reasonable size and shape. Use the first page or pages for the inventory. Upon the first double pages following the inventory, write at the top of the page the word "receipts," and on the

opposite page at the right the word "expenditures." As money is paid out or received in cash, enter it on the book by date and amount.

Keep all these accounts until the close of the month, and then balance the account. Draw two lines close together, leave a little space, and then begin the new account. If the page is full turn to the next two pages and write "receipts" and "expenditures" as before.

In case there is a balance on hand after closing the account of the previous month, enter the amount under "receipts" as "balance brought forward." If there is a deficit, enter this amount under "expenditures" as "deficit brought forward."

Do the same for each month; and at the close of the year the books will show, when the new inventory is made, whether there has been a profit or loss.

For all ordinary purposes only one book is necessary. If a man desires to make allowances for his own work or for that of the members of his family, the estimated value of the labor should be itemized with the "expenditures." By careful accounting he will be able to determine at the close of the year what has been the returns for their labor.

1. Suppose on January 1, 1914, a farmer has on hand \$25 cash; January 3, buys one ton of bran at \$24; January 5, sells 2 hogs @ \$16 each;

January 8, sells 30 bushels of corn for \$18; January 15, pays \$22 for labor; January 18, buys 10 pigs for \$55; January 23, sells 475 bushels of wheat at \$1.05 per bushel; January 25, sells 7 tons of hay at \$12 per ton; January 26, sells a horse at \$175. Indicate these amounts in the account book and then open up the books ready for the accounts during February.

## LEFT-HAND PAGE

1914			
Jan. 1	Cash on hand	\$ 25	00
Jan. 5	Two hogs @ \$16 each	32	00
Jan. 8	30 bushels of corn @ 60¢	18	00
Jan. 23	475 bushels of wheat @ \$1.05	498	75
Jan. 25	7 tons of alfalfa hay @ \$12	84	00
Jan. 26	1 horse	175	00
		<b>\$832</b>	<b>75</b>

## RIGHT-HAND PAGE

1914			
Jan. 3	1 ton of bran	\$ 24	00
Jan. 15	Labor to Frank Williams	22	00
Jan. 18	10 shoats @ \$5.50 each	55	00
Jan. 31	By balance	731	75
		<b>\$832</b>	<b>75</b>

In starting the month of February the balance, or \$731.75, would be placed on the page given to

“receipts” dated February 1 as “balance brought forward.” Other items would then be entered as usual under either “receipts” or “expenditures.”

### Study Lesson

#### 65. How to keep special accounts.

If a farmer wishes to know how much he is making or losing on his business each year, or what has been the profit or loss on each crop or class of animals, it is necessary for him to keep special accounts. These accounts should cover the different crops, the live stock, labor, personal accounts, etc.

In keeping a record of live stock a separate account should be kept for each kind. Likewise for each of the grain crops, since on one crop there might be a gain, while on another a loss; and hence, if only one account is kept, there might be a gain on all together but a loss on some one of them.

An account of live stock, fruit, garden, poultry, etc., may be kept in exactly the same way. The profit or loss for the year, on everything, will be the difference between the sums of the profits and losses on the different items. It would be well for every farmer to keep from time to time the special accounts, even if he does not think it advisable to keep them all during the same year.

The following is an account of the total cost of production and the receipts, on 60 acres of wheat:

1913	EXPENDITURES	RECEIPTS
Aug. 15 For plowing 60 acres	\$82.80	
Sept. 5 Preparing land, 5 days for 4 teams . . .	63.60	
Oct. 1 Seed wheat, 75 bushels @ 90¢ . . . . .	67.50	
Oct. 4 4 days drilling, 4 drills	24.00	
1914		
July 1 Cutting and shocking	60.00	
July 24 Threshing 1200 bushels	48.00	
July 27 Threshing labor . .	50.00	
July 30 Hauling to market .	26.00	
July 30 Sold 1000 bushels @ \$1		\$1000.00
Sept. 1 Sold 150 bushels for seed @ \$1.25 . . .		187.50
Sept. 1 Used for exchange for flour, 50 bushels .		50.00
Interest on 60 acres land @ 4% . . . .	144.00	
Taxes . . . . .	75.00	
Totals . . . . .	\$640.90	\$1237.50
Profit . . . . .		596.60

### Written Problems

66. 1. Itemize, using the local yield and price, the cost of producing 50 acres of corn.

2. Make up a similar account with a 20-acre field of alfalfa.

3. The following account was kept in connection with the record of a 14-acre field of potatoes. Arrange the items in the form shown above. June 3, 160 bushels of seed @ 45¢ per bushel; June 4, corrosive sublimate, 3 ounces @ 10¢ per ounce; June 10,  $43\frac{3}{4}$  bushels of seed @ 55¢ per bushel; June 11, corrosive sublimate, 6 ounces at 10¢ per ounce; July 12, Paris green, 6 pounds @ 22¢ per pound; July 15, lead arsenate, 160 pounds at 9¢ per pound; use of land, \$5 per acre; man labor, 796 hours @ 19.02¢ per hour; horse labor, 839 hours @ 10.46¢ per hour; equipment labor, 839 hours @ 3.5¢ per hour; manure,  $\frac{3}{8}$  of the 1912 application, \$20; manure, all of the 1913 application, \$30; sold, Oct. 6, 226 bushels @ 60.18¢ per bushel; Oct. 20, 510 bushels @ 62¢ per bushel; Nov. 1, 241 bushels @ \$1.083; saved for seed, 135 bushels @ \$1; saved for home use, 16 bushels @ 60¢ per bushel; saved  $\frac{3}{8}$  of the 1913 manure and  $\frac{3}{10}$  of the 1912 manure. What were the profits?

3. Itemize the following dairy herd account and find the gain or loss: inventory, \$1950; feed, \$1403.40; labor, \$560; interest and housing, \$330; incidentals, \$57; dairy sales, \$1998.10; skim milk, \$300; manure, \$510; milk for home, \$73; December 31, inventory, \$2175.

## DENOMINATE NUMBERS \*

**67. A denominate number** is a quantity whose unit of value has been fixed by law or usage, as 3 feet, 4 pounds.

A **simple denominate number** is one composed of a single denomination, as 5 gallons.

A **compound denominate number** is one composed of units of two or more denominations, as 6 bushels 2 pecks.

## ENGLISH UNITS OF MEASURE

### Linear Measure

**68. Linear measure** is used in measuring lengths and distances. The unit of measure is the yard.

#### MEMORIZE THE TABLE

12 inches (in.)	= 1 foot (ft.)
3 feet	= 1 yard (yd.)
$5\frac{1}{2}$ yards	= 1 rod (rd.)
$16\frac{1}{2}$ feet	= 1 rod
320 rods	= 1 mile (mi.)
5280 feet	= 1 mile.

\* NOTE. — For tables of Miscellaneous Measures see Appendix II.

**Surface Measure**

**69.** A **surface** has two dimensions, length and width. A plane surface, bounded by any number of lines, is called a **polygon**. If the polygon has four sides and the corners square, it is called a **rectangle**. The **area of a rectangle** equals the product of the length and width. **Square measure** is used to measure areas.

**MEMORIZE THE TABLE**

144 square inches (sq. in.)	= 1 square foot (sq. ft.)
9 square feet	= 1 square yard (sq. yd.)
$30\frac{1}{4}$ square yards	= 1 square rod (sq. rd.)
$272\frac{1}{4}$ square feet	= 1 square rod
160 square rods	= 1 acre (A.)
640 acres	= 1 section (sec.)

**Cubic Measure**

**70.** **Cubic measure** is used in measuring solids. If the faces of the solid are rectangles, the solid is called a **rectangular solid**, and the volume is equal to the product of the length by the width by the depth, or height.

**MEMORIZE THE TABLE**

1728 cubic inches (cu. in.)	= 1 cubic foot (cu. ft.)
27 cubic feet	= 1 cubic yard (cu. yd.)
128 cubic feet	= 1 cord of wood
$24\frac{3}{4}$ cubic feet	= 1 perch of stone
1 cubic foot of water	weighs $62\frac{1}{2}$ pounds.



**Avoirdupois Weight**

**71. Avoirdupois weight** is used in weighing all ordinary articles.

**MEMORIZE THE TABLE**

16 ounces (oz.)	= 1 pound (lb.)
100 pounds	= 1 hundredweight (cwt.)
20 cwt. or 2000 pounds	= 1 ton (T.)
2240 pounds	= 1 long ton (L.T.)

The **long ton** is used in United States custom-houses in determining the duty on merchandise taxed by the ton. It is also used in wholesale transactions in coal and iron at the mines.

**Liquid Measure**

**72. Liquid measure** is used in measuring the capacity of tanks, cisterns, buckets, etc. The liquid gallon contains 231 cubic inches. A gallon of water weighs about  $8\frac{1}{3}$  pounds.

**MEMORIZE THE TABLE**

4 gills (gi.)	= 1 pint (pt.)
2 pints	= 1 quart (qt.)
4 quarts	= 1 gallon (gal.)

**Dry Measure**

**73. Dry measure** is used in measuring grain, fruit, vegetables, etc. The standard unit is the Winchester bushel, which contains 2150.42 cubic inches, and is a cylinder  $18\frac{1}{2}$  inches in diameter

and 8 inches deep. A dry gallon contains 268.8 cubic inches.

**MEMORIZE THE TABLE**

2 pints (pt.)	= 1 quart (qt.)
8 quarts	= 1 peck (pk.)
4 pecks	= 1 bushel (bu.)

**Measure of Time**

**74.** The **mean solar day** is the unit for measuring time, and is the interval of time from the instant the sun crosses any meridian until it crosses the same meridian the next noon. A mean solar year equals 365 days, 5 hours, 48 minutes, and 46 seconds, or about  $365\frac{1}{4}$  days.

The Gregorian calendar is now used by nearly all civilized nations; and, according to the plan of this calendar, every year whose date number is divisible by four is a leap year, unless the date number ends in two zeros, in which case the date number must be divisible by 400 in order to be a leap year.

**MEMORIZE THE TABLE**

60 seconds (sec.)	= 1 minute (min.)
60 minutes	= 1 hour (hr.)
24 hours	= 1 day (da.)
7 days	= 1 week (wk.)
30 days	= 1 month (mo.)
12 months	= 1 year (yr.)
365 days	= 1 year
366 days	= 1 leap year

**THE METRIC SYSTEM OF MEASURE**

**75.** The **metric system** of measure was adopted by France in 1795. The meter is the unit of measure, and was obtained by dividing the distance from the equator to the pole into 10,000,000 equal parts. The **meter**, approximately 39.37 inches, is the unit of length.

**Measure of Length****MEMORIZE THE TABLE**

10 millimeters (mm.)	= 1 centimeter (cm.)
10 centimeters	= 1 decimeter (dm.)
10 decimeters	= 1 meter (M.)
10 meters	= 1 decameter (Dm.)
10 decameters	= 1 hectometer (Hm.)
10 hectameters	= 1 kilometer (Km.)
10 kilometers	= 1 myriameter (Mm.)

In the abbreviations the small letters are used for the lower denominations.

**Measure of Capacity**

**76.** The **liter** is the unit of capacity. It equals a cubic decimeter, or 1.0567 quarts liquid measure, or .908 quart dry measure. The liter is used in measuring liquids in small quantities, the decaliter in measuring large quantities, and the hectoliter in

measuring grain. Four liters are slightly more than a gallon. Thirty-five liters are almost a bushel.

**MEMORIZE THE TABLE**

10 milliliters (ml.)	= 1 centiliter (cl.)
10 centiliters	= 1 deciliter (dl.)
10 deciliters	= 1 liter (L.)
10 liters	= 1 decaliter (Dl.)
10 decaliters	= 1 hectoliter (Hl.)
10 hectoliters	= 1 kiloliter (Kl.)
10 kiloliters	= 1 myrialiter (Ml.)

**Measure of Weight**

**77.** The **gram** is the unit of weight, and is the weight of one cubic centimeter of distilled water at the temperature of melting ice. The gram equals .03527 of an ounce avoirdupois. The **kilogram** is the common unit of weight, and is equal to about  $2\frac{1}{8}$  pounds avoirdupois.

**MEMORIZE THE TABLE**

10 milligrams (mg.)	= 1 centigram (cg.)
10 centigrams	= 1 decigram (dg.)
10 decigrams	= 1 gram (G.)
10 grams	= 1 decagram (Dg.)
10 decagrams	= 1 hectogram (Hg.)
10 hectograms	= 1 kilogram (Kg.)
10 kilograms	= 1 myriagram (Mg.)
1000 kilograms	= 1 tonne (T.)

**78.****Table of Equivalents**

TABLE OF EQUIVALENTS FOR REFERENCE	
1 centimeter	= .3937 inch
1 meter	= 39.37 inches
1 kilometer	= .6214 mile
1 foot	= 30.48 centimeters
1 yard	= .9144 meter
1 mile	= 1.609 kilometers
1 gram	= 15.43 grains or .0353 oz.
1 kilogram	= 2.204 pounds
1 liter	= .9081 dry quart or 1.057 liquid quarts
1 dry quart	= 1.101 liters
1 liquid quart	= .9464 liter
1 gallon	= 3.785 liters
1 bushel	= 35.24 liters

**REDUCTION OF DENOMINATE NUMBERS****Reduction Descending**

**79. Reduction Descending** means changing a denominate number from a larger to a smaller unit.

1. Reduce 36 rd. 4 yd. 2 ft. to feet.

**Process**

36 rd. 4 yd. 2 ft.

5½

198

4

202 yd.

3

606

2

608 ft. *Ans.*

**Explanation:** 1 rd. = 5½ yd., 36 rd.  
 = 36 × 5½ yd. = 198 yd. 198 yd. + 4  
 yd. = 202 yd. 1 yd. = 3 ft. 202 yd.  
 = 202 × 3 ft. = 606 ft. 606 ft. + 2  
 ft. = 608 ft. Hence 36 rd. 4 yd. 2 ft.  
 = 608 ft.

**Written Exercise**

80. 1. Reduce 2 mi. 32 rd. 3 yd. 2 ft. 10 in. to inches.
2. Reduce 18 gal. 3 qt. 1 pt. to pints.
  3. How many inches in  $\frac{3}{8}$  of a mile?
  4. Reduce  $\frac{7}{8}$  square meter to square centimeters.
  5. How many grams in one pound?
  6. Reduce  $\frac{3}{8}$  kilogram to ounces.
  7. Reduce one acre to square feet.
  8. Reduce 25 gal. 2 qt. 1 pt. to liters.

**Written Problems**

81. 1. Find the number of minutes in the month of January.
2. A cubic foot of distilled water weighs about  $62\frac{1}{2}$  pounds. What is the weight of 3 cu. yd. 20 cu. ft.?
  3. A dairyman delivers 120 gallons of milk daily,  $\frac{2}{3}$  in pint bottles and the rest in quart bottles. How many bottles of each kind are necessary?
  4. How many iron rails each 60 feet long will be required to lay a railroad track 24 miles long?
  5. What is the cost per hour to light a room with 54 burners each consuming  $2\frac{1}{4}$  cu. in. a second, the price of gas being 95¢ a thousand cubic feet?

**Reduction Ascending**

**82.** Reduction ascending means changing a denominate number from a lower to a higher unit.

1. Reduce 175 pt. to bushels, pecks, and quarts.

Process	Explanation:
$  \begin{array}{r}  2 \overline{)175} \\  8 \overline{)87} \\  4 \overline{)10} \\  \underline{\phantom{0}} 2 \text{ bu.} + 2 \text{ pk.}  \end{array}  $	$  \begin{array}{l}  2 \text{ pt.} = 1 \text{ qt.} \quad 175 \\  \text{pt.} = 87 \text{ qt. and } 1 \text{ pt.} \quad 8 \text{ qt.} = 1 \text{ pk.} \\  87 \text{ qt.} = 10 \text{ pk. and } 7 \text{ qt.} \quad 4 \text{ pk.} = 1 \\  \text{bu.} \quad 10 \text{ pk.} = 2 \text{ bu. and } 2 \text{ pk.} \\  \text{Therefore: } 175 \text{ pt.} = 2 \text{ bu. } 2 \text{ pk.} \\  7 \text{ qt. } 1 \text{ pt. } \textit{Ans.}  \end{array}  $

**Written Exercise**

- 83.** 1. Reduce 1500 pints to higher units.  
 2. Reduce 1787 yards to miles, rods, and yards.  
 3. Reduce 17,897 inches to higher units.  
 4. Reduce 7862 centimeters to higher units.  
 5. Reduce 107,240 oz. to pounds and tons.  
 6. Reduce 21,937 ft. to higher units.  
 7. Reduce 1728 gills to higher units.  
 8. Reduce 6745 minutes to hours, days, and months.  
 9. Reduce 94,685 seconds to minutes and degrees. See Appendix.  
 10. Reduce 78,425 cu. in. to cubic feet and cubic yards.  
 11. Reduce 136,484 sq. ft. to square yards, square rods, and acres.

**Written Problems**

**84. 1.** A farmer harvested 87 bu. 3 pk. 6 qt. of wheat from 5 acres of land. At \$1.15 a bushel what was the value of the crop per acre?

**2.** If it takes 4 qt. of oats for one feeding of a horse, how many bushels will it take to feed 6 horses a year, giving them two feedings a day?

**3.** How many feet per second are equivalent to 40 miles an hour?

**4.** A tank 9 by 4 by 5 feet holds how many kilograms of water?

**5.** Find the value of a field 440 meters long and 620 meters wide at \$75 an acre.

**ADDITION AND SUBTRACTION**

**85. 1.** Add: 8 gal. 3 qt. 1 pt. 2 gi.; 12 gal. 2 qt. 3 gi.; 7 gal. 2 qt. 1 pt. 2 gi.; 4 gal. 2 qt. 1 pt. 2 gi.

**Process**

gal.	qt.	pt.	gi.
8	3	1	2
12	2	0	3
7	2	1	2
4	2	1	2
33	3	1	1

**Explanation:** Write the numbers to

be added so that units of the same denomination will be in the same column. Beginning with the lowest find the sum of the column of gills, or 9 gills = 2 pt. 1 gi. Write the 1 gi. under the proper column and carry the 2 pt. to the column of pints. The sum of the second column is 5 pints, or 2 qt. 1 pt. Bring down the 1 pt., carry the 2 to the quart column, and add. The sum is found to be 11 qt., or 2 gal. 3 qt. Write down the 3 qt. and carry the 2 gal. to the gallons column, obtaining 33 for the sum. The result is then: 33 gal. 3 qt. 1 pt. 1 gi. *Ans.*



2. From 27 bu. 3 pk. 2 qt. take 12 bu. 3 pk. 4 qt.

**Process**

bu.	pk.	qt.
27	3	2
12	3	4
14	3	6

**Explanation:** Write the minuend and subtrahend with units of the same denomination in the same column. Since we cannot subtract 4 qt. from 2 qt. we take 1 pk., or 8 qt., from the 3 pk., which combined with the 2 qt. make 10 qt. 4 qt. from 10 qt.

leaves 6 qt. Again, we cannot take 3 pk. from 2 pk., so we take 1 bu. or 4 pk. from the 27 bu., which added to the 2 pk. make 6 pk. 3 pk. subtracted from 6 pk. leaves 3 pk. 12 bu. from 26 bu. leaves 14 bu.

Hence our result is : 14 bu. 3 pk. 6 qt. *Ans.*

**Written Exercise**

86. Add:

	gal.	qt.	pt.	qt.
1.	6	3	2	3
	5	2	1	2
	6	1	1	3

	mi.	rd.	yd.	ft.	in.
3.	6	140	3	2	8
	8	143	5	2	0
	7	17	0	0	0
	0	167	3	2	9
	79	143	5	2	7

	bu.	pk.	qt.	pt.
2.	5	3	6	1
	7	2	5	1
	9	3	3	1
	8	3	5	1
	8	1	7	0

	A.	sq. rd.	sq. yd.	sq. ft.	sq. in.
4.	9	143	23	7	126
	18	86	15	7	87
	17	159	27	3	115
	16	98	17	6	143

5. Add: 10 T. 7 cwt. 55 lb.; 17 T. 9 cwt. 85 lb.; 19 T. 11 cwt. 60 lb.; 13 T. 8 cwt. 18 lb.; and 16 T. 17 cwt. 28 lb.

6. Find the sum of  $\frac{5}{8}$  of a day,  $7\frac{3}{4}$  hr.  $91\frac{1}{2}$  min. 53 sec. and 7 da. 11 hr. 8 min. 16 sec.

Subtract:

	rd.	yd.	ft.	in.
7.	76	4	2	6
	38	5	2	8

	A.	sq. rd.	sq. yd.	sq. ft.
8.	19	143	25	6
	8	103	26	3

9. From 96 bu. 3 pk. 2 qt. take 23 bu. 3 pk. 5 qt. 1 pt.

10. From 125 mi. take  $\frac{5}{8}$  of a rod.

11. From  $\frac{7}{8}$  of a rod take  $\frac{7}{8}$  of a yard.

### Written Problems

87. 1. From a 20-acre field 6 acres 150 square rods were sold. What was the remainder worth at \$75 an acre?

2. What is the distance around a field whose sides are: 32 rd. 4 yd.; 27 rd. 4 yd.; and 28 rd. 5 yd.?

3. A milk dealer bought 9 gal. 2 qt. 1 pt. of milk from one man; 7 gal. 1 qt. from another; and 14 gal. 3 pt. from a third. What was the milk worth at 6¢ a quart?

4. Three fields of alfalfa hay produced 14 T. 8 cwt. 85 lb., 18 T. 12 cwt. 60 lb., and 16 T. 7 cwt. 45 lb., respectively. How much hay did the three fields produce?

5. A gardener sold four loads of potatoes containing 49 bu. 18 lb., 51 bu. 27 lb., 48 bu. 32 lb., and 46 bu. 27 lb. What was their value at 85¢ a bushel?

# **MULTIPLICATION AND DIVISION OF DENOMINATE NUMBERS**

**88. 1.** Multiply 8 gal. 2 qt. 1 pt. by 9.

Process			Explanation: 1 pt. $\times$ 9 = 9 pt. or 4 qt.		
gal.	qt.	pt.	1 pt.	2 qt. $\times$ 9 = 18 qt.	18 qt. + 4 qt. =
8	2	1	22 qt. or 5 gal. 2 qt.	8 gal. $\times$ 9 = 72 gal.	
		9	72 gal. + 5 gal. = 77 gal.	The final result	
77	2	1	is: 77 gal. 2 qt. 1 pt. <i>Ans.</i>		

**2.** Divide 17 T. 7 cwt. 15 lb. by 5.

Process			Explanation: 17 T. + 5 = 3 T. and a remainder of 2 T. 2 T. or 40 cwt. + 7		
T.	cwt.	lb.	cwt. = 47 cwt.	47 cwt. + 5 = 9 cwt.	
5)17	7	15	and a remainder of 2 cwt. 2 cwt. or	200 lb. + 15 lb. = 215 lb.	215 lb. + 5 =
3	5	43	43 lb. Hence our result is 3 T. 9 cwt. 43 lb. <i>Ans.</i>		

## **Written Exercise**

- 89. 1.** Multiply 5 gal. 3 qt. 1 pt. 3 gi. by 23.
- 2.** Multiply 6 mi. 207 rd. 4 yd. 2 ft. 8 in. by 17.
- 3.** Multiply 17 sq. rd. 8 sq. yd. 7 sq. ft. 17 sq. in. by 15.
- 4.** Multiply 5 A. 125 sq. rd. 29 sq. ft. 38 sq. in. by 43.5.
- 5.** Divide 25 mi. 178 rd. 4 yd. 2 ft. by 7.
- 6.** Divide 10 lb. 12 oz. by 2 lb. 7 oz.
- 7.** Divide 78 da. 40 min. 40 sec. by 1.4.
- 8.** Divide 45 bu. 2 pk. 5 qt. 1 pt. by 1 bu. 1 pk. 1 qt. 1 pt.

**Written Problems**

90. 1. A sack holds 2 bu. 1 pk. 4 qt. of wheat. How much wheat will 45 such sacks hold?

2. If land is valued at \$1200 an acre, what is a  $50 \times 150$  foot lot worth?

3. A bin  $\frac{2}{3}$  full contains 25 bu. 3 pk. of oats. What is its capacity?

4. Ten gallons of 40% cream worth 50¢ a quart are mixed with 10 gallons of milk worth 6¢ a quart. What must be the selling price per quart of the mixture in order not to lose?

5. A ton of coal contains 35 cu. ft. How many tons will a bin 12 ft. 8 in. by 5 ft. 7 in., and 4 ft. 3 in. deep, hold?

6. A bushel of potatoes contains  $1\frac{1}{4}$  cubic feet. How many bushels will a wagon box hold that is 12 feet long, 3 ft. 8 in. wide, and 2 feet deep?

7. A carriage wheel revolves 3 times in going 11 yards. How many times will it revolve in going  $\frac{4}{5}$  of a mile?

8. A tract of land containing 6 A. 150 sq. rd. was divided into 31 lots of equal size. How much land did each contain?

**Written Problems — Review**

91. 1. How many acres in a field 40 rods by 80 rods? What part of a section is the field?

2. How wide must a plot of land be to contain an acre, if it is 160 rods in length?

3. A rectangular field contains 35 acres. If it is 40 rods wide, what is its length?

4. A field is 60 rods by 80 rods. How wide a strip must be plowed along the side of the field to plow an acre? Across the end?

5. Approximately 300 pounds of water are required to produce one pound of dry matter of corn. How many gallons would be required to mature a shock of corn weighing 350 pounds?

6. If an acre produced 50 bushels (72 pounds per bushel) of corn and 3600 pounds of stalks and leaves, how many gallons of water would be used in maturing the crop?

7. A rainfall of one inch upon an acre would weigh how many pounds? How many gallons? How many inches of rainfall would be required in maturing an acre of corn of 50 bushels?

8. The average rainfall for Iowa during the year 1913 was about 29.95 inches. What fractional part of this would be required to yield 60 bushels of corn, and 4300 pounds of stalks and leaves, if all of it were available for use?

9. After a series of rains the total rainfall was found to be 3 inches. It was estimated that  $\frac{4}{5}$  of the water ran off at once, while the rest soaked into the ground to be used by the plants. What

was the number of pounds per acre left for the plants to use?

10. In a recently plowed field  $\frac{5}{8}$  of the water soaked into the ground. How many pounds per acre were taken up by the soil?

11. The total rainfall at Manhattan, Kan., is about 30 inches. What does the water weigh that falls on a square yard of ground during the year? How many gallons?

12. Plants use about  $\frac{1}{3}$  of this amount. What is the weight of water used by an acre of vegetation?

13. It requires about 310 pounds of water to grow the grass that will make one pound of timothy hay. How much water will be required to produce an acre of hay yielding 2 tons to the acre? How much rainfall?

14. A field of wheat that yielded 315 bushels is 80 rods long by  $27\frac{1}{2}$  rods wide. What was the yield per acre?

15. How many trees will be required to set ten rows 40 rods long if the trees are  $8\frac{1}{4}$  feet apart in the rows? Make a drawing.

16. If raspberries yield 3600 quarts per acre, how many quarts should 10 rows, 60 feet long and 3 feet apart, yield? Illustrate by drawing.

17. If 10 rows of raspberries are 60 feet long and the plants 3 feet apart in the rows, how many plants are required? Illustrate by drawings.

18. How many square rods of surface does it require for 10 rows of raspberries 60 feet long with the rows 6 feet apart? Make a drawing.

19. If raspberries yield 3000 quarts per acre, how many quarts should be obtained from the patch referred to in Problem 18?

20. If berries shrink one half in canning, what is the cost of putting up a bushel crate of fresh berries when they are 40¢ a gallon and quart cans are 90¢ a dozen? What is the cost per quart?

21. If a field yields 19,440 pounds of wheat, what is the yield per acre if the field is 64 by 30 rods?

22. A field is 40 rods by 20 rods. What will be the total cost to place a wire fence around it at 22¢ per rod for the wire and 17¢ each for the posts? The posts are to be one rod apart.

23. A farmer placed 2000 bushels of corn in a crib November 15. The following spring the weight showed a shrinkage of 14,000 pounds. If the market price was 60¢ a bushel at that time, how much did he gain or lose by keeping the corn until May 1, receiving 65¢ per bushel? The taxes on the corn were \$28.

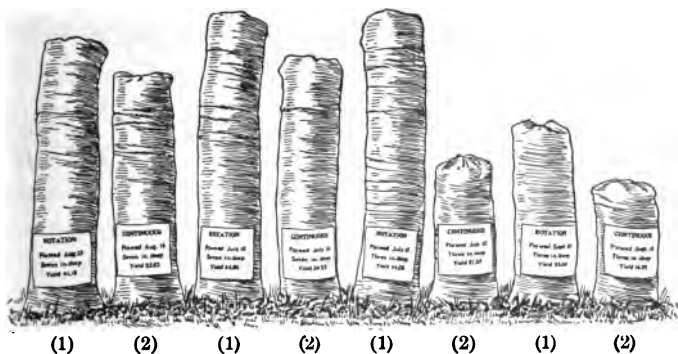
24. Clover seed of average quality weighs about 1.5 grams per 1000 seeds. How many seeds to the pound?

## GRAPHS AND THEIR APPLICATION

### Study Exercise

**92.** The graph has come to be a very common form of expression, especially where statistics are to be presented. A much clearer conception of magnitudes can often be obtained by representing them by lines, letting the length of the lines bear direct relations to the size of the numbers to be represented. There are a great many ways of representing data graphically, such as by different lengths of lines, by pictures of varying sizes, etc.

**1.** The picture given here represents the effect of continuous cropping as against rotation in the production of wheat at the Kansas State Experiment Station.

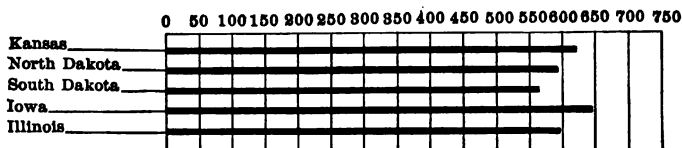


Compare the corresponding yields:

Rotation	(1)	41.16	44.56	44.08	22.50	bu. per acre.
Continuous	(2)	32.83	34.95	21.57	16.39	bu. per acre.



2. The amount of wheat produced by the five leading wheat states in the United States may be represented as shown below :



### Written Exercise

93. 1. Represent the yield of corn in the following states: Illinois, 426,320,000; Iowa, 432,021,000; Indiana, 174,600,000; Kansas, 174,225,000; and Nebraska, 182,616,000 bushels.

2. The number of milch cows in Wisconsin in 1913 was 1,007,000; in Missouri, 1,337,000; in Kansas, 698,000; in Indiana, 634,000; and in Illinois, 1,007,000. Represent as above.

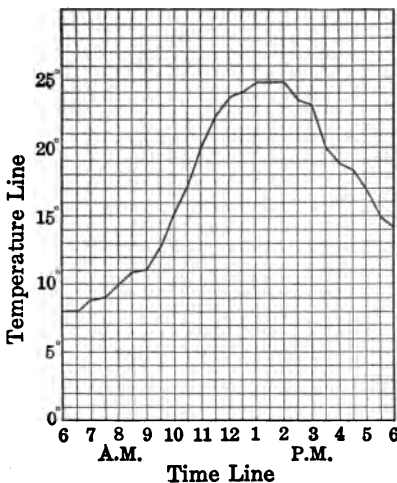
3. Exhibit in the form of horizontal parallel lines the following facts relative to Kansas production values from 1893 to 1912 in millions of bushels: wheat, 832; corn, 1082; oats, 157; hay, 286; and live stock products, 1,436.

4. According to the government census report, the values of some of the chief mining products of the United States for 1909 were in millions of dollars: bituminous coal, 401; anthracite coal, 149; petroleum and natural gas, 176; copper, 99; iron, 107; precious metals, 88. Represent the facts by lines as above.

5. The values of products of the leading industries in the United States for 1909 were in millions of dollars: packing, 1,371; foundry and machine shop, 1,228; lumber, 1,156; steel, 986; flour, 884; printing, 738; cotton, 628. Express graphically.

### The Use of Squared Paper

94. By means of squared paper the results of experiments and observations, statistical tables, and numerical data of all kinds can be represented by lines and curves. A close study of the following figure, which represents the change of temperature for a certain period, will give an idea of the method of representation. The thermometer was connected with an instrument which marked



out by means of a needle every change of temperature for every minute during the day. The paper was arranged on a rotating cylinder which was regulated by a clock. By approximating the time and temperature one is enabled to tell the temperature at any period during the time.

**Oral Exercise**

**95.** Answer the following questions by reference to the temperature graph :

1. What temperature is recorded at the beginning and at the end of the observations?
2. What is the highest and what is the lowest temperature recorded?
3. At what time was the highest temperature recorded?
4. At what times did the instrument record a temperature of 20 degrees? 24 degrees? 15 degrees?
5. When did the instrument record the slowest changes of temperature? the most sudden?
6. What was the nature of the change of temperature from 9 A.M. until noon?

Study the graph carefully and determine the temperature for the half hour periods.

**Written Problems**

**96. 1.** Represent as above the temperature on February 24, 1914:

6:00 A.M.	4	2:00 P.M.	40
7:00 A.M.	6	2:30 P.M.	40
8:00 A.M.	8	3:00 P.M.	38
8:30 A.M.	9	4:00 P.M.	26
9:00 A.M.	10	4:30 P.M.	24
10:00 A.M.	18	5:00 P.M.	20
10:30 A.M.	22	5:30 P.M.	15
11:00 A.M.	32	6:00 P.M.	10
12:00 M.	35	7:00 P.M.	4
1:00 P.M.	36	8:00 P.M.	0

2. Represent by means of the squared paper the following facts regarding the average monthly rainfall in inches at North Platte, Nebr., for 35 years ending 1909 :

Jan. .42	May 2.86	Sept. 1.47
Feb. .49	June 3.41	Oct. 1.10
Mar. .81	July 2.90	Nov. .46
Apr. 2.04	Aug. 2.37	Dec. .49

3. Construct a temperature chart from the following data regarding the mean monthly temperature for Ohio from 1888 to 1909 :

Jan. 28.9	May 60.	Sept. 65.5
Feb. 28.1	June 69.6	Oct. 52.5
Mar. 38.8	July 73.1	Nov. 41.4
Apr. 49.7	Aug. 71.3	Dec. 31.8

4. In an orchard heating experiment at the Iowa Station on the night of May 1, 1911, the following temperature readings were taken :

Location	A.M.	2:30	3:00	3:15	3:30	4:00	4:30	5:00	6:00	7:00	8:00
Inside heated area		29½	31½	32½	32	31½	32½	33	34	36	38
Outside heated area		29	28½	28	27½	26½	26½	26½	26½	34	38

Represent the above data by means of a graph, thereby visualizing the effect of the heaters. Use colored chalk or different kinds of broken lines to represent the two sets of facts. The heating pots were lighted between 2:30 and 3:15 A.M., and opened wider at 4:00 A.M. The figures in the table are the averages of several readings.

5. Show graphically the rise in orchard temperature due to the use of heaters in accordance with

the following tabulated results of an experiment at the Iowa station:

Location	A.M.	2:00	3:00	3:15	3:30	4:00	4:30	5:00	5:30	5:45	6:00
Heated area		—	—	29	31	35	32	32	32	37	32
Unheated area		31	29	29	29	29	29	30	29	29	29

The heaters were lighted at 3:15 A.M. The somewhat abrupt variations in the temperature of the heated area are due to the partial opening and closing of the covers of the heaters.

6. The average values per acre of United States farm land during recent decades were in round numbers:

1850	\$14	1870	\$22	1890	\$26	1910	\$47
1860	\$20	1880	\$23	1900	\$24		

Represent the above data by means of a graph.

7. Exhibit by means of a coördinate graph the following table of percentages of school attendance of the total population of the United States from 6 to 20 years of age:

AGE	PER CENT	AGE	PER CENT	AGE	PER CENT
6	52	11	91	16	51
7	75	12	90	17	35
8	83	13	89	18	23
9	86	14	81	19	14
10	90	15	68	20	8

8. Represent graphically the following facts concerning the death rate from tuberculosis in the United States from 1900 to 1912 per 100,000 population:

YEAR	DEATHS	YEAR	DEATHS	YEAR	DEATHS
1900	202	1904	201	1908	167
1901	197	1905	193	1909	162
1902	185	1906	181	1910	161
1903	188	1907	178	1911	159
				1912	149

9. Construct a rain chart from the following precipitation table at Hays, Kansas, from 1903 to 1913:

YEAR	RAINFALL IN INCHES	YEAR	RAINFALL IN INCHES	YEAR	RAINFALL IN INCHES
1903	32.5	1907	25.4	1911	17.1
1904	15.8	1908	25.4	1912	20.2
1905	20.7	1909	28.3	1913	23.1
1906	23.1	1910	16.2		

10. At the Wisconsin Experiment Station the following table of results was obtained from different groups of dairy cows for the year 1910. The net profits are found by deducting the cost of feed from the value of milk and butter fat:

GROUP	AV. BUTTER FAT IN POUNDS	AV. NET PROFIT IN DOLLARS	GROUP	AV. BUTTER FAT IN POUNDS	AV. NET PROFIT IN DOLLARS
1	674	115	8	421	63
2	569	91	9	399	54
3	529	85	10	375	46
4	494	74	11	355	50
5	472	69	12	327	45
6	456	70	13	275	30
7	438	68			

Exhibit these results graphically. Note relations between the two curves obtained from the second and third columns of figures.

## MEASUREMENTS

### PARALLELOGRAM AND TRIANGLE

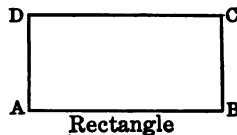
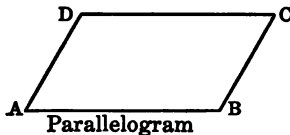
**97.** A **polygon** may be defined as a plane figure bounded by any number of straight lines. The point where two sides meet is called a **vertex**. The distance around a polygon is called its **perimeter**. A line joining any two vertices not adjacent is called a **diagonal** of the polygon.

A **quadrilateral** is a polygon having four sides.

A **parallelogram** is a quadrilateral whose opposite sides are parallel.

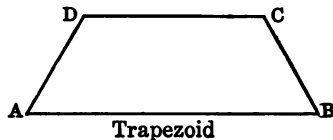
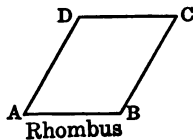
A **rhombus** is a parallelogram having equal sides.

A **rectangle** is a parallelogram whose angles are right angles.



A **square** is a rectangle having equal sides.

A **trapezoid** is a quadrilateral with one pair of opposite sides parallel.

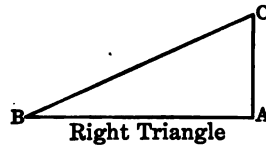
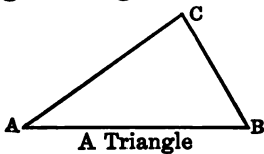


A **triangle** is a polygon having three sides.

The side upon which the figure rests is called the **base**.

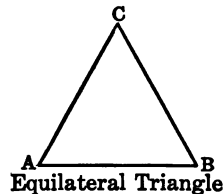
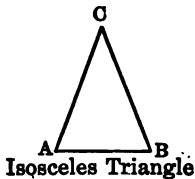
The perpendicular distance from the base to the opposite vertex is called the **altitude**.

A triangle having one right angle is called a **right triangle**.



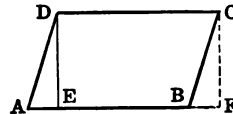
A triangle with two equal sides is called an **isosceles triangle**.

A triangle with three equal sides is called an **equilateral triangle**.



### Study Exercise

98. By a study of the accompanying figure it can be seen that any parallelogram may be made into a rectangle having the same base and altitude. Therefore, the area of a parallelogram is equal to the product of the base by the altitude.





**Formula :**

Area = base  $\times$  altitude.

$$A = ba.$$

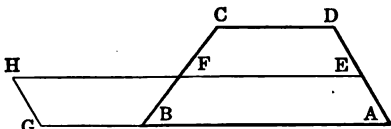


The figure above shows that the diagonal divides the parallelogram into two equal triangles. Therefore the area of a triangle is equal to one half the product of the base and altitude.

**Formula :** Area =  $\frac{1}{2}$  base  $\times$  altitude.

$$A = \frac{1}{2} ba.$$

If the trapezoid  $ABCD$  is cut by  $EF$  midway between  $AB$  and  $CD$ , and the upper part is placed so that  $CF$  will fall upon  $BF$ , a parallelogram is formed with a base equal in length to the sum of the upper and lower bases. The altitude equals to one half the altitude of the trapezoid; hence, the area of a trapezoid equals one half the altitude times the sum of the two bases.



**Formula :**  $A = \frac{1}{2} a(b + b')$

### Written Exercise

99. Find the area of the following figures :

1. Rectangle, base 96 rods, altitude 64 rods.
2. Rectangle, base 84 feet, width 45 feet.
3. Parallelogram, length 73 rods, altitude 37 rods 4 yards.

4. Parallelogram, length 105 feet 4 inches, altitude 77 feet 3 inches.
5. Triangle, base 56 feet, altitude 27 feet.
6. Triangle, base 37 feet, altitude 29 feet.
7. Triangle, base 89 feet 7 inches, altitude 77 feet 3 inches.
8. Trapezoid, lower base 58 feet, upper base 46 feet, altitude 25 feet.
9. Trapezoid, lower base 26 feet, upper base 16 feet, altitude 8 feet.
10. Trapezoid, lower base 39 feet, upper base 23 feet, altitude 15 feet.

### Written Problems

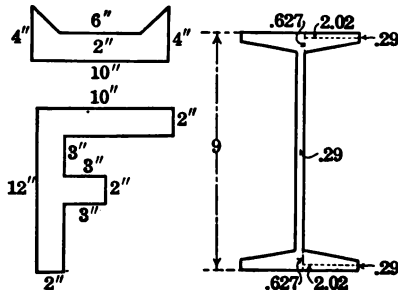
- 100.** 1. Find the area of the surface of an open box which is 6 ft. long, 5 ft. wide, and 4 ft. deep.
2. How many acres in a triangular field whose base is 480 rods and altitude 260 rods?
3. A triangular field 96 rods long contains 12 acres. Find the altitude.
4. What will be the cost to lay a six-foot walk in front of and on one side of a 50 by 150 foot lot, at 12¢ a square foot?
5. How many bricks 8 by 4 by 2 inches will it take to lay the walk in Problem 4, figuring that a row of bricks be laid on edge entirely around the walk?

6. What does it cost to produce a field of wheat 160 rods by 86 rods at \$9.67 an acre?

7. If a wheat drill is 8 feet wide, what part of an acre will be covered in going across a field 160 rods long? How many times across would it take to cover 12 acres?

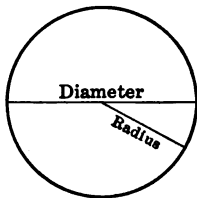
8. What is the area of a board 14 feet long and 12 inches wide at one end and 9 inches wide at the other?

9. Find the area of the following figures:



### CIRCLES

**101.** A closed curve such that all of its points are equally distant from a point within is called a **circle**.



A straight line from the center to the circle is called a **radius**.

A straight line through the center, terminated at each end by the circle, is called a **diameter**.

By measuring accurately a circle, and then measuring the diameter, and dividing the circumference or distance around the circle by the

diameter, the result will be approximately  $3\frac{1}{7}$ . Hence the circumference of a circle is approximately equal to  $3\frac{1}{7} (\pi)$  times the diameter, or 2 times  $\pi$  times the radius.  $\pi$  is more accurately given as 3.1416.

**Formula:**  $C = 2 \pi r$ .

1. **Example:** Find the circumference of a circle whose radius is 18 inches.

**Process**

Circumference = 2 pi times the radius.

$$C = 2 \pi r.$$

Therefore,  $C = 2 \times 3.1416 \times 18 = 113.0976$ . *Ans.*

**Written Exercise**

**102.** Find the circumference of the following circles, using  $\pi$  as  $3\frac{1}{7}$ :

- |                        |                         |
|------------------------|-------------------------|
| 1. Diameter 14 inches. | 5. Diameter 4.56 feet.  |
| 2. Diameter 28 inches. | 6. Diameter 14.9 feet.  |
| 3. Diameter 47 inches. | 7. Diameter 426 feet.   |
| 4. Diameter .39 inch.  | 8. Diameter 115.6 feet. |

Find the circumference of the following circles, using  $\pi$  as 3.1416:

- |                         |                               |
|-------------------------|-------------------------------|
| 1. Diameter 32 feet.    | 5. Radius 167.7.              |
| 2. Diameter 765 feet.   | 6. Radius 154.3.              |
| 3. Diameter .76 foot.   | 7. Radius $\frac{7}{8}$ foot. |
| 4. Diameter 49.52 feet. | 8. Radius $\frac{3}{7}$ foot. |

**Written Problems**

**103.** 1. A circular piece of ground 33.94 rods in diameter is bordered by a running track. Find the length of the track.

2. Find the circumference of a 2-inch pipe. Of a  $2\frac{1}{2}$ -inch pipe.

3. Find the circumference of a wheel 3 feet 6 inches in diameter.

4. Find the diameter of a circular cistern whose circumference is 14 feet 8 inches.

5. Find the circumference of a globe whose radius is 2 inches. 24 inches. 30 inches.

6. Find the diameter of a circular race track whose distance around is 880 rods.

7. Find the distance around the earth, if its diameter is 7918 miles.

8. The moon's radius is about 1082 miles. Find its circumference.

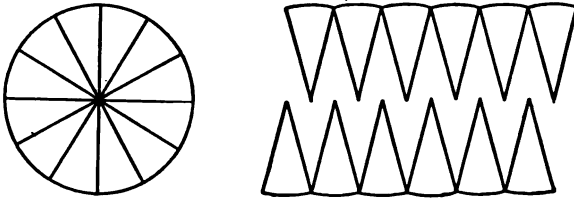
**Areas of Circles**

**104.** The method of finding the area of a circle is established in geometry and cannot be taken up here.

**Rule:** The area of a circle is equal to one half the circumference times the radius.

**Formula:**  $S = \frac{1}{2} Cr.$

Draw a circle and then divide the circumference into equal parts. Draw the radii, cut along the



radii from the center almost to the circumference, and then spread out the entire circle into two parts. The area of the circle is nearly equal to a rectangle whose base is one half the circumference and whose altitude is equal to the radius.

The circumference is equal to  $2\pi r$ . The area is equal to one half the circumference times the radius, or one half of  $2\pi r$  times  $r = \pi r^2$ .

**Rule:** The area of a circle equals  $\pi$  times the radius squared, or  $\frac{1}{4}$  of  $\pi$  times the square of the diameter.

**Formula:**  $S = \pi r^2$ .

Find the area of a circle 14 feet in diameter.

**Formula:** Area =  $\pi$  times the radius squared.

$$S = \pi r^2$$

The diameter is 14 ; hence the radius is 7.

**Explanation:**  $\therefore$  Area =  $3.1416 \times (7)^2 = 152.9384$  feet. *Ans.*

**Written Exercise**

**105.** Find the area of each of the following circles :

1. Circumference 34 inches.
2. Circumference 154 feet.
3. Circumference 66.4 feet.
4. Circumference 105.7 feet.
5. Diameter 18 feet.
6. Diameter  $\frac{8}{9}$  foot.
7. Diameter 6 feet 7 inches.
8. Radius 6 inches.
9. Radius 37.2 feet.
10. Radius  $\frac{5}{6}$  inch.
11. Radius .56 foot.
12. Radius 7.83 yards.

**Written Problems**

**106.** 1. Find the area of the cross section of a rod one and a half inches in diameter.

2. A half mile circular race track incloses how many acres of land ?

3. Find the area of a ring whose inside diameter is 8 inches, and whose outside diameter is 10 inches.

4. In a steel plate  $3\frac{1}{2}$  feet by  $2\frac{1}{2}$  feet are bored 28 round holes, each  $1\frac{1}{4}$  inches in diameter. Find the area of the steel remaining.

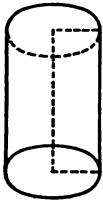
5. The radii of two circles are 3 feet and 6 feet. The area of the second is how many times the area of the first?

6. A circular sheet of steel 2 feet 4 inches in diameter increases in diameter by  $\frac{1}{250}$  of its diameter when the temperature is raised by a certain amount. Find the increase in the area of the sheet.

7. Find the area of the largest circle that can be cut from a piece of paper 8.5 inches square.

8. Find the area of a watch crystal  $1\frac{3}{4}$  inches in diameter.

## SOLIDS



107. A **circular cylinder** is a solid which has two equal circles joined by a uniformly curved surface called the lateral area.

A **pyramid** is a solid having a polygon for a base and triangles for sides.



A **circular cone** is a solid having a circle for a base and tapering to a point.

The **altitude of a cylinder** is the perpendicular distance between the two bases, and of a pyramid or cone it is the perpendicular distance from the vertex to the base.

The **slant height of a pyramid** is the altitude of any one of the triangles forming its lateral surface.



The **slant height of a cone** is the shortest distance from the vertex to the circumference of its base.

The **lateral surface of a cylinder** equals the product of the altitude by the circumference of the base.

**Formula:**  $S = 2 \pi r h.$

The **volume of a cylinder** is equal to the product of the height by the area of the base.

**Formula:**  $V = \pi r^2 h.$

The **lateral surface of a pyramid or cone** equals one half the perimeter of the base by the slant height.

**Formula:**  $S = \frac{1}{2} p s.$

The **volume of a pyramid or cone** equals one third the area of the base by the altitude.

**Formula:**  $V = \frac{1}{3} B h.$

### Written Exercise

**108.** Find the surface and volume of the following solids:

1. A cylinder with diameter 5 feet, height 5 feet.
2. A cylinder with radius 7 feet, height 7 feet.
3. A cylinder with radius 6 feet 3 inches, height 25 feet.
4. A pyramid with base a square 7 feet on a side, height 9 feet, slant height 9.65 feet.
5. A pyramid with base a square 9 feet on a side, height 12 feet, slant height 12.8 feet.

6. A pyramid whose base is an equilateral triangle with sides 16 feet and area 110.8 sq. ft., height 24 feet, and slant height 24.42 feet.

7. A cone the diameter of whose base is 6 feet, height 8 feet, and slant height 8.54 feet.

8. A cone the diameter of whose base is 12 feet, height 15 feet, and slant height 16.15 feet.

9. A cone the radius of whose base is 18 feet, height 24 feet, and slant height 30 feet.

### Written Problems

109. 1. How many bushels of potatoes in a conical pile 8 feet across and 3 feet high if it requires  $1\frac{1}{3}$  cubic feet for a bushel?

2. How many bushels of corn in a conical pile 15 feet across and 5 feet high if  $2\frac{1}{2}$  cubic feet equals one bushel?

3. How many square feet of tin will it take to make a stovepipe 6 inches in diameter and 2 feet 8 inches long? Allow one inch in the width for making the seam.

4. If one gallon of paint covers 250 square feet, how many gallons of paint will be required for a silo 20 feet in diameter and 32 feet in height?

5. Find the capacity in tons of a silo 20 ft. in diameter and 36 feet high, if a cubic foot of silage weighs 40.7 pounds.

6. What must be the diameter of a 30-foot silo in order to hold enough silage to feed 28 cows 40 pounds a day for 165 days, if the silage weighs 40 pounds per cubic foot?

7. The outside diameter of a hollow cylindrical cast-iron shaft 18 ft. long is 21 inches, the inside diameter is 12 inches. Find the weight if cast iron weighs .26 pound per cubic inch.

8. A circular stack of hay 12 feet in diameter has perpendicular sides to a height of 6 feet and then tapers to a point, the entire height being 15 feet. Counting 512 cubic feet to a ton, how many tons in the stack?

9. A grain bin with a hopper bottom is 13 feet square and is 16 feet deep to the hopper. The hopper has a depth of 5 ft. How many bushels will it hold?

10. A cylindrical grain bin with a hopper bottom is 16 feet in diameter and 18 feet deep to the hopper. The hopper is 6 feet deep. How many bushels will it hold?

11. A pump with a 6-inch stroke has a 3-inch cylinder. How much water will it deliver per stroke?

12. A cylindrical hot water storage tank is guaranteed to withstand a pressure of 85 pounds per square inch. What is the total guaranteed pressure for the inside of a tank that is 5 feet high and 12 inches in diameter?

## PRACTICAL MEASUREMENTS

### PLASTERING, PAPERING, AND PAINTING

**110.** Plastering is commonly measured by the square yard. No allowances are made for very small openings; and usually one half the area of the doors and windows is allowed in estimating the labor. A full allowance is made for the openings in estimating the materials. The laths are put up in bundles of 50 each, and from 28 to 30 bundles are required for 100 square yards of surface. For two coats with brown finish  $2\frac{1}{2}$  barrels of lime, 45 cubic feet of sand, 4 bushels of hair, and 10 pounds of three-penny nails for the lathing, are required.

Wall paper is usually 18 inches wide and is sold by the roll. A single roll is 8 yards long and a double roll is 16 yards. Borders vary in width from 3 inches upward. In papering deductions are not made for borders, since no allowances are made for matching. One very common way of estimating the number of double rolls required for a room is to find the number of square feet above the base-board in the walls and ceiling, deduct for openings, and divide by 70.

Painting is usually measured by the square yard,

and no allowances are made for openings in estimating the labor. The amount of paint needed to cover a surface varies with the nature of the surface; however, under ordinary circumstances one gallon of paint will cover from 250 to 300 square feet with two coats.

### Study Exercise

**111.** 1. How many square feet in the walls and ceiling of a room 12 ft. wide, 15 ft. long, and 9 feet high if there are 2 doors 7 ft. by 3 ft. 6 in., and 3 windows 6 ft. by 3 ft.?

### Process and Explanation

$$\text{Area of walls} = 2 \times 12 \times 9 + 2 \times 15 \times 9 = 486 \text{ sq. ft.}$$

$$\text{Area of ceiling} = 12 \times 15 = 180 \text{ sq. ft.}$$

$$\text{Total area} \quad \quad \quad 666 \text{ sq. ft.}$$

Openings:

$$2 \text{ doors} = 2 \times 7 \times 3\frac{1}{2} = 49 \text{ sq. ft.}$$

$$3 \text{ windows} = 3 \times 6 \times 3 = 54 \text{ sq. ft.}$$

$$\text{Total for openings} \quad \quad 103 \text{ sq. ft.}$$

$666 \text{ sq. ft.} - 103 \text{ sq. ft.} = 563 \text{ sq. ft.}$  in the walls and ceiling. *Ans.*

### Written Exercise

**112.** Determine the number of square feet in the walls and ceilings of the following rooms, if there are two doors 7 ft. 6 in. by 3 ft. 6 in., and 3 windows  $6\frac{1}{2}$  ft. by 3 ft.:

1. 16 ft. wide, 20 ft. long, and 10 ft. high.

2. 13 ft. wide, 15 ft. long, and  $9\frac{1}{2}$  ft. high.

3. 14 ft. wide, 16 ft. long, and 9 ft. high.
4. How many square feet in the sides and ends of a barn 40 ft. wide, 60 ft. long, and 20 ft. high with gables extending 16 feet above the walls?

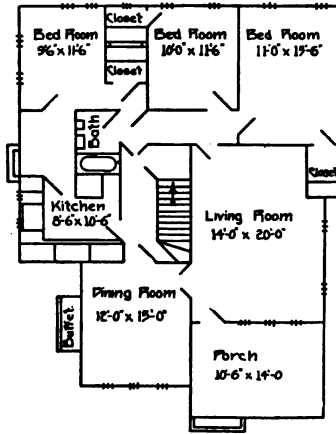
### Written Problems

**113.** 1. What will it cost to plaster a room 12' by 16' by 9' with two coats, brown finish, at 47¢ per square yard, if there are two doors and three windows in the room with dimensions 7' 6" by 4' and 6' 6" by 3' 8" respectively?

2. What will it cost to rough finish two bedrooms at 34¢ per square yard if the rooms are 12' by 14' and 10' by 12' respectively? Each room is 8' high.

3. What will it cost for the material to paint a five-room cottage 24' by 30' if it is 8' up to the plates and there are three gables, each 24' wide and 8' high? Paint is \$2.15 per gallon, and one gallon covers 250 square feet two coats.

4. A room is 18' square, has three windows and three doors, a 9-inch baseboard, and a 9-foot



ceiling. What will it cost to paper the room at 35 ¢ per double roll?

Reference in the following problems is made to the cottage shown in the accompanying diagram.

5. What will it cost to lath and plaster the two adjoining bedrooms at 32 ¢ per square yard? Height of room 9' 6", doors 7' 6" by 4', and windows 6' 6" by 3' 8".

6. Find the cost of hard finishing the walls and ceilings of the living room and dining room at 47 ¢ per square yard, dimensions of doors and windows as in the preceding problem and the length of the buffet is 6 ft.

7. Find the cost of papering the walls and ceilings of the three bedrooms at 45 ¢ per double roll, making an allowance for an 8-inch baseboard.

8. Find the cost of papering the kitchen with sanitary wall paper at 32 ¢ per double roll.

9. Find the cost of papering the two front rooms with paper at 40 ¢ per double roll for walls and 25 ¢ per double roll for the ceilings, running picture moldings at 3 ¢ per foot, baseboard as above.

10. If one gallon of paint covers 300 square feet of surface with 2 coats, find the amount of paint required to give two coats to a house 42 feet long, 36 feet wide, 20 feet high, and with gables 18 feet high. Find the cost of the paint at \$2.15 per gallon.

## ROOFING

**114.** Roofing is usually estimated by the square, or a section 10 feet square, or 100 square feet. Shingles are estimated as having an average width of 4 inches. They are laid 4,  $4\frac{1}{2}$ , 5,  $5\frac{1}{2}$ , and 6 inches to the weather. Shingles are put up in bunches of 250 to the bunch, and only whole bunches are sold.

A roof is said to be half pitch, quarter pitch, five eighths pitch, etc., when the rise is  $\frac{1}{2}$ ,  $\frac{1}{4}$ ,  $\frac{5}{8}$ , etc., times the full width of the building.

The following table allows for waste and gives the number of shingles required to lay a square of roofing when laid at various distances to the weather.

INCHES TO THE WEATHER	NUMBER TO COVER A SQUARE
4	1000
$4\frac{1}{2}$	900
5	800
$5\frac{1}{2}$	700
6	650

1. How many bunches of shingles laid  $4\frac{1}{2}$  inches to the weather will be required for a double roof 30 feet wide and 40 feet long?

**Process**

$$\frac{2 \times 30 \times 40}{100} = 24 \text{ squares.}$$

$$\frac{24 \times 900}{250} = 86\frac{2}{5} \text{ bunches.}$$

Hence 87 bunches will be needed.

**Explanation:** Each

side of the roof is a rectangle 30 by 40 ft. Hence  $2 \times 30 \times 40$  equals the number of square feet which divided by



100 gives the number of squares. It takes 900 shingles for a square, and for 24 squares it takes  $24 \times 900$ , or 21,600. If 21,600 be divided by 250, the result is the required number of bunches.

### Written Exercise

**115.** 1. In the table above how many shingles in each case have been allowed for waste?

2. Find the number of bunches required for a shed roof 20 by 30 feet if laid 5 inches to the weather.

3. What is the pitch of each of the following roofs?

(a) Width of building 24 feet, rise 8 feet.

(b) Width of building 40 feet, rise 16 feet.

(c) Width of building 30 feet, rise 12 feet.

4. What is the rise if the width of the building is 40 feet and pitch  $\frac{1}{2}$ ?  $\frac{1}{4}$ ?  $\frac{1}{3}$ ?  $\frac{5}{8}$ ?

### Written Problems

**116.** 1. How many bunches of shingles, laid  $4\frac{1}{2}$  inches to the weather, are required to cover the roof of a barn 60 feet long, with rafters 26 feet long?

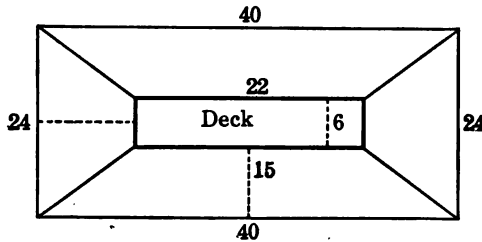
2. A barn is 65 feet by 45 feet and is 20 feet to the eaves with the roof  $\frac{1}{3}$  pitch. Find the cost of painting it at 42¢ per square yard for double coat.

3. The roof dimensions of a house are 46' by 18'. The house has one porch with roof dimen-

sions 20' by 12'. Find the cost of the shingles at \$ 3.25 per M if laid 4" to the weather.

4. A conical steeple 25 feet in diameter at the base and having a slant height 40 feet will require how many shingles to cover it if laid  $5\frac{1}{2}$  inches to the weather?

5. The rain which falls on a roof 18 by 32 feet is carried to a cylindrical cistern 7 feet in diameter. How many inches of rainfall would it take to fill the cistern to a depth of 6 ft.?



6. The accompanying figure represents the plan of a roof. The deck is to be covered with tin. How many shingles will be required for the roof if laid 4 inches to the weather?

### BOARD MEASURE

**117.** In measuring lumber the unit is the board foot. This is defined as a square foot of surface on a board one inch thick. Boards less than one inch in thickness are considered as if they were an inch thick. For each additional fractional part of

an inch the corresponding fractional part must be added. Thus a board 16 feet long, 1 foot wide, and  $1\frac{1}{2}$  inches in thickness contains 24 board feet.

**Rule:** To find the number of board feet multiply length in feet by the width times the thickness in inches and divide by 12.

$$\text{Board feet} = \frac{\text{Width} \times \text{length} \times \text{thickness}}{12}$$

**Formula:**  $B. F. = \frac{wlt}{12}$

1. Find the number of board feet in 25 scantling  $2'' \times 4''$  by  $18'$  long.

**Process**

$$25 \times \frac{2 \times 4}{12} \times 18 = 300 \text{ B. F.}$$

**Explanation:** For every foot in length there are  $\frac{2 \times 4}{12}$  board feet, which if

multiplied by the length and the number of scantling will give the total number of board feet.

### Written Exercise

Find the number of board feet in:

118. 1. 30 boards  $1''$  by  $12''$  by  $10'$ .
2. 60 boards  $1''$  by  $10''$  by  $16'$ .
3. 40 boards  $2''$  by  $6''$  by  $12'$ .
4. 24 planks  $1\frac{1}{2}''$  by  $20''$  by  $18'$ .
5. 36 planks  $3''$  by  $9''$  by  $18'$ .

**Written Problems**

**119. 1.** A house is 40' by 32' by 18'. How many feet of siding will it require, allowing  $\frac{1}{8}$  for lapping? Find the cost at \$ 28 per M.

**2.** Find the number of feet of lumber required to side a barn 60' by 32' by 18' to the eaves, with roof at  $\frac{1}{2}$  pitch. Find the cost at \$ 22.50 per M.

**3.** A yard 8 rods by 16 rods is to be fenced with 4 running boards of 6-inch stuff. The posts are placed 8 feet apart, and 2"  $\times$  4" railing pieces are used at the top and bottom. Find the cost of the fence if the boards are \$ 23 per M, scantling \$ 21.50 per M, and posts at \$ 24 per C.

**4.** Find the amount of the following bill of lumber:

25 scantling 2 in. by 4 in. by 10 ft. @ \$ 22 per M.

20 scantling 4 in. by 4 in. by 12 ft. @ \$ 22 per M.

30 scantling 2 in. by 6 in. by 16 ft. @ \$ 22 per M.

2200 ft. of ship lap @ \$ 25 per M.

2500 ft. siding @ \$ 26.50 per M.

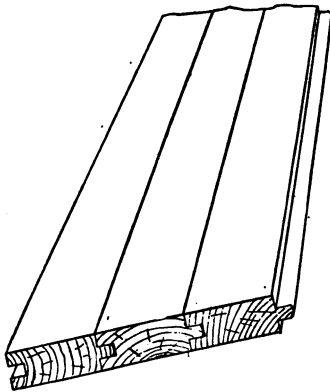
150 bunches of shingles @ \$4.15 per M.

1650 posts @ \$ 20 per hundred.

**5.** Find the number of board feet in 8 planks 2 in. by 8 in. by 12 ft.; 12 planks 3 in. by 8 in. by 18 ft.; 24 planks  $2\frac{1}{4}$  in. by 14 in. by 18 ft.; and 18 planks  $2\frac{1}{2}$  in. by 12 in. by 18 ft. What will be the entire cost at \$ 18 per M?

**FLOORING**

**120.** The boards for flooring are tongued and grooved. On account of the tongues and grooves



about  $\frac{3}{8}$  of an inch of the width is deducted. A three-inch board then really covers a strip only  $2\frac{5}{8}$  inches wide. For flooring from about  $2\frac{1}{2}$  to  $5\frac{1}{2}$  inches wide, the amount added for matching and waste is  $\frac{1}{4}$  of the total floor space. For flooring less than  $2\frac{1}{2}$  inches,  $\frac{1}{3}$  is added.

1. How much flooring will be required for a room 12 by 16 feet if 2-inch material is used?

**Process**

$$12 \times 16 \times \frac{1}{3} = 256.$$

of feet of lumber required.

**Explanation:** The room is a rectangle 12 by 16; and since  $\frac{1}{3}$  is to be allowed for waste,  $\frac{1}{3}$  times the number of square feet will be the number

**Written Problems**

**121.** 1. Find the cost of three-inch flooring material for the porch of the cottage, p. 101, at \$42 per M.

2. Find the total cost of 3-inch hardwood flooring material for the interior floor space of the

cottage at \$ 65 per M. Estimate the floor space with dimensions not given at 300 square feet.

3. How much 3-inch flooring will it take to lay a floor 16 feet by 18 feet? How much  $1\frac{1}{2}$ -inch?

4. How much 6-inch flooring is required for a room 14' 6" by 15' 10"?

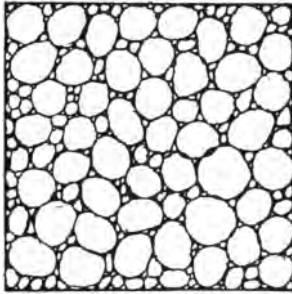
5. What will it cost to floor a room 12' by 15' with  $1\frac{1}{2}$ -inch oak at \$ 3.80 per hundred feet?

6. A kitchen floor is 10' 8" by 9' 3". If it is laid with 2-inch hard maple flooring, what will the lumber cost at \$ 65 per M?

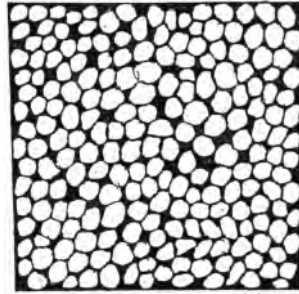
### CEMENT CONSTRUCTION

**122.** Concrete is a mixture of water, cement, and an aggregate composed of sand, gravel, or broken stone in certain definite proportions, which when allowed to harden forms an artificial stone. The materials are mixed in some stated proportion; *e.g.*, 1 part of cement, 2 parts of sand, and 4 parts of gravel. These parts are always measured in volume, and the proportion is known as a 1 : 2 : 4 mixture.

The cement may be purchased in sacks weighing approximately 100 pounds, or containing about  $\frac{1}{4}$  barrel or about 1 cubic foot. The crushed stone, gravel, and sand should be so graded in size that they will pack together in such a way as not to leave any large openings.



VARYING AGGREGATE



UNIFORM AGGREGATE

The diagrams above show the economy in the use of varying aggregate.

The sand should not be too fine and should be perfectly clean. In mixing, the cement should be brought into contact with all the particles of the material so that it will have a chance to bind them all together.

Taylor and Thompson in a *Treatise on Concrete* make four proportions which differ in the relative quantities of cement. These proportions are as follows :

- (1) **Rich** —  $1 : 1\frac{1}{2} : 3$  for columns and structural parts subjected to heavy stresses.
- (2) **Standard** —  $1 : 2 : 4$  for floors, beams, and columns.
- (3) **Medium** —  $1 : 2\frac{1}{2} : 5$  for walls, piers, sidewalks, etc.
- (4) **Lean** —  $1 : 3 : 6$  for heavy mass work which is only in compression.

For determining the amount of material in a cubic yard of concrete, the following formulas, known as Fuller's Rule, give fairly good results :

**Formulas:**

$$P = \frac{11}{c+s+g}, \text{ barrels of cement required for 1 cubic yard of concrete.}$$

$$S = P \times s \times \frac{3.8}{27}, \text{ cubic yards of sand required for 1 cubic yard of concrete.}$$

$$G = S \times \frac{g}{s} = P \times g \times \frac{3.8}{27}, \text{ cubic yards of gravel required for 1 cubic yard of concrete.}$$

In these formulas

$c$  equals the number of parts of cement.

$s$  equals the number of parts of sand.

$g$  equals the number of parts of gravel or broken stone.

**Written Exercise**

**123.** 1. Using Fuller's Rule fill in the blanks below and thus get a table of proportions for mixing cement:

FORMULA	SACKS CEMENT	CU. YDS. SAND	CU. YDS. GRAVEL	1 CUBIC YD.
1:2:4				
1:2½:5				
1:3:6				
1:4:8				
1:3:5				
1:2:3				
1:1				

**Written Problems**

**124.** 1. How many barrels of cement, and how many cubic yards of sand and aggregate will be



needed for  $2\frac{1}{2}$  cubic yards of concrete, if a 1 : 3 : 5 mixture is used ?

2. How many cubic yards of concrete will it take to build an 8-inch cellar wall 24 ft. by 30 ft. by  $7\frac{1}{2}$  ft. deep ?

3. How many sacks of cement will it take to build the wall referred to in problem 2? How many cubic yards of sand and aggregate, if a  $1 : 2\frac{1}{2} : 5$  mixture is used ?

4. How many cubic yards of concrete will be required to put in a 4-inch floor in a cellar 24 ft. by 30 ft. ? What will be the cost of the cement at 45 ¢ per sack if a  $1 : 2\frac{1}{2} : 5$  mixture is used ?

5. How many cubic yards of concrete will be required to make a watering trough 8 ft. by 4 ft. by 2 ft. inside dimensions, if the thickness is 4 inches ?

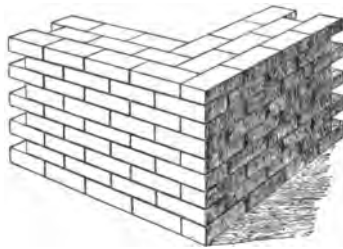
6. How many sacks of cement will be needed for the trough if a 1 : 2 : 4 mixture is used ?

7. How many sacks of cement will be needed to build a walk 50 feet long,  $4\frac{1}{4}$  feet wide, and 4 inches thick, besides a  $\frac{1}{2}$ -inch finishing coat ? The main part of the walk is to be made with a  $1 : 2\frac{1}{2} : 5$  and the finishing coat with a 1 : 1 mixture.

8. If the volume of a concrete post is 1.5 cubic feet, how many sacks of cement will be required to make 100 fence posts with a 1 : 3 : 6 mixture ? What will be the cost if the cement is 45 ¢ per sack, the sand and the gravel each 75 ¢ per cubic yard ?

## BRICKWORK AND STONEWORK

**125.** A common brick is 2 in. by 4 in. by 8 in. If placed in a wall, the side exposed to the outside, it will occupy a space 2 in. by 8 in., or 16 square inches. The mortar is usually about one-half inch thick between the bricks; so approximately 7 bricks are required to lay a wall one brick thick for every square foot, 15 if two, and 22



if three bricks thick. In estimating the cost of labor no allowances are made for openings, but a full allowance is made for openings in estimating the material. A bricklayer will lay from 1800 to 2000 bricks per day. It is customary to consider the outside perimeter of the walls as the length of the wall to be built.

The unit of measure for walls built of stone is the perch. A perch equals  $24\frac{3}{4}$  cubic feet. In common practice a perch is considered as 25 cubic feet. In excavating, one cubic yard of earth is considered a load.

## Study Exercise

**126. 1.** How many bricks will be required for a cellar wall 18 feet wide, 24 feet long, and 8 feet high, three bricks thick?

**Analysis**

The perimeter of the wall is  $2 \times 18$  plus  $2 \times 24 = 84$  feet.

$84 \times 8 = 672$  square feet of wall.

$672 \times 22$  bricks = 14,784 bricks. *Ans.*

2. How many perch of stone will be required for the same wall?

**Analysis**

Since the number of square feet in the wall is 672 and it is one foot thick, there are 672 cubic feet in the wall. One perch equals 25 cubic feet; hence,  $672 \div 25 = 26.9$ , or about 27 perch. *Ans.*

**Written Problems**

127. 1. How many bricks will be required to build a cellar wall 18 ft. by 25 ft. by 7 ft., two bricks thick? Three bricks thick?

2. How many bricks will be required to build a chimney 30 feet high, if the opening from top to bottom is 8 in. by 8 in.?

3. Find the approximate number of bricks it will take to wall a cistern 8 feet deep and 8 feet in diameter from the bottom up to within two feet of the top. The wall then tapers to a 2-foot diameter and requires 200 bricks.

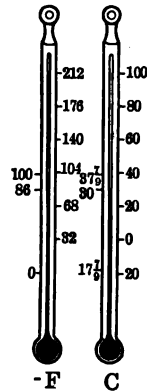
4. The cellar for an ordinary eight-room house will be 28 ft. by 30 ft. How many bricks will it take to wall the cellar if the walls are 8 feet high, two bricks thick?

5. How many perch of stone will it require to build the same wall? What will be the difference in price if the bricks are worth \$ 8 per M and the stone is \$ 16 per perch ?

6. The ordinary cement blocks are 16 in. by 8 in. by 8 in. How many cement blocks will it take to build the cellar wall in Example 4? What will be the price at 18 ¢ apiece?

### TEMPERATURE

**128.** For measuring temperature two kinds of thermometers are most widely used — the Fahrenheit for ordinary purposes, and the Centigrade for scientific work. On the Fahrenheit scale the 32 degree mark indicates the freezing point of water, and the 212 degree mark the boiling point. On the Centigrade thermometer zero is the freezing point, and 100 degrees is the boiling point. The scale distance between these limits is spaced equally into degrees. Degrees above zero are marked by the plus sign, and those below zero by the minus sign.



### Study Exercise

**129.** 1. Change 60° F. to C.

**Process**

Since  $180^{\circ}\text{ F.} = 100^{\circ}\text{ C.}$  between boiling and freezing,

$$1^{\circ}\text{ F.} = \frac{100}{180} = \frac{5}{9}^{\circ}\text{ C.}$$

$$60^{\circ} - 32^{\circ} = 28^{\circ}\text{ above freezing.}$$

$$28^{\circ}\text{ F.} = 28 \times \frac{5}{9} = 15\frac{4}{9}^{\circ}\text{ C.} \quad \text{Ans.}$$

To change Fahrenheit reading to Centigrade reading use

**Formula :**  $\text{C.}^{\circ} = \frac{5}{9}(\text{F.}^{\circ} - 32^{\circ}).$

**2. Change  $20^{\circ}\text{ C.}$  to F.**

**Process**

Since  $100^{\circ}\text{ C.} = 180^{\circ}\text{ F.}$

$$1^{\circ}\text{ C.} = \frac{9}{5}^{\circ}\text{ F.}$$

$$20^{\circ}\text{ C.} = 20 \times \frac{9}{5} = 36^{\circ}\text{ F.}$$

$$20^{\circ}\text{ C.} = 36^{\circ}\text{ F. above freezing.}$$

$$0^{\circ}\text{ C.} = 32^{\circ}\text{ F.}$$

$$\therefore 20^{\circ}\text{ C.} = 36^{\circ}\text{ F.} + 32^{\circ}\text{ F.} = 68^{\circ}\text{ F.} \quad \text{Ans.}$$

To change Centigrade reading to Fahrenheit reading use

**Formula :**  $\text{F.}^{\circ} = \frac{9}{5}\text{ C.} + 32^{\circ}.$

**Written Exercise**

**130.** 1. Change  $128^{\circ}\text{ F.}$ ;  $22^{\circ}\text{ F.}$ ; and  $68^{\circ}\text{ F.}$  to Centigrade.

2. Change  $22^{\circ}\text{ C.}$ ;  $35^{\circ}\text{ C.}$ ; and  $-12^{\circ}\text{ C.}$  to Fahrenheit.

3. The boiling point of the following substances are: benzine,  $176^{\circ}\text{ F.}$ ; mercury,  $676^{\circ}\text{ F.}$ ; ether,  $96^{\circ}\text{ F.}$ ; iodine,  $347^{\circ}\text{ F.}$  Find the corresponding Centigrade reading.

4. The melting point of the following substances are: sulphur,  $115^{\circ}\text{ C.}$ ; zinc,  $420^{\circ}\text{ C.}$ ; aluminum,

658° C.; platinum, 1775° C.; gold, 1380° C.; cast iron, 1200° C. Find the corresponding Fahrenheit temperatures.

5. The temperature of cream for best results in churning is about 65° F. What should be the reading Centigrade?

6. The temperature of the human body is about 98° F.; of the pigeon, 110° F.; of the rabbit, 103° F. What are the corresponding temperatures Centigrade?

### LONGITUDE AND TIME

**131.** For fixing locations on the surface of the earth, use is made of imaginary lines, called **meridians**, running north and south from pole to pole, and also of imaginary lines running east and west parallel to the equator. From these systems of lines two have been taken, one from each set, as the axes of reference. The meridian passing through Greenwich, England, called the Prime Meridian, and the equator are the chosen lines from which reckonings are made. Distances from these axes are given in degrees.

**Longitude** is the distance east or west from the Prime Meridian.

**Latitude** is the distance north or south of the equator. For example, 87° 37' 30" W. and 41° 53' 3" N. fixes the position of Chicago.

**Study Exercise**

**132.** From the fact that the earth rotates upon its axis once in 24 hours, any point on its surface passes in that time through 360 degrees.

By comparing the number of degrees passed through with the time it takes to pass, a convenient table may be developed. It follows:

**360°** are equivalent to **24** hours of time.  
**15°** are equivalent to **1** hour of time.  
**1°** is equivalent to **4** minutes of time.  
**1'** is equivalent to **4** seconds of time.

Since 24 hours of time corresponds to 360 degrees of longitude, the following table results:

**24** hours are equivalent to **360°**.  
**1** hour is equivalent to **15°**.  
**1** minute is equivalent to **15'**.  
**1** second is equivalent to **15''**.

1. The difference of longitude between Washington and San Francisco is  $45^{\circ} 21' 15''$ . What is the difference in time?

<b>Process</b>	<b>Explanation:</b>
$\begin{array}{r} 15 \overline{) 45^{\circ} 21' 15''} \\ \underline{3^{\circ} \phantom{00} 1' 25''} \phantom{00} \\ \phantom{00} 0^{\circ} 1' 25'' \end{array}$	Since $15^{\circ}$ are equivalent to one hour of time, $45^{\circ} 21' 15''$ will be equivalent to as many hours as 15 is contained
	times in it. The problem then is a simple one in the division of Denominate Numbers.

2. The difference of time between Greenwich, England, and Chicago is 5 hrs. 42 min. 30 sec. What is the difference in longitude?

Process			Explanation:
5 hr.	42 min.	30 sec.	Since 1 hr. is equivalent to 15° of longitude,
		15	1 min. equivalent to 15', and
87°	37'	30"	1 sec. equivalent to 15'', 5 hr.
			42 min. 30 sec. is equivalent to
			15 times as much, or 87° 37' 30''.

### Written Exercise

**133.** Find the difference in time between:

1. Denver, 105° 4' W. and Vicksburg, 90° 54' W.
2. Constantinople, 28° 59' E. and New York, 74° 0' 3'' W.
3. St. Louis, 90° 14' W. and Paris 2° 20' 22'' E.
4. Portland, Oregon, 122° 27' 30'' W. and Peking, 116° 27' 30'' E.

The difference of time between Greenwich and the following places is given. Find their longitude.

5. Liverpool, 12 min. 17.3 sec. W.
6. St. Louis, 6 hr. 49 sec. W.
7. Hong Kong, 7 hr. 36 min. 41.6 sec. E.
8. Denver, 6 hr. 59 min. 47.6 sec. W.
9. Find the difference in longitude between Denver and Hong Kong.



**Written Problems**

**134.** 1. The longitude of New Orleans is  $90^{\circ} 5' W.$  and that of Constantinople is  $28^{\circ} 59' 15'' E.$  What is their difference in local time? When it is 3 P.M. in Constantinople what is the time at New Orleans?

2. A vessel at  $54^{\circ} 17' 30'' W.$  sent a wireless message to one at  $61^{\circ} 24' 50'' W.$  at 10 A.M. If transmitted without loss of time, when was the message received?

3. The longitudes of Washington and San Francisco are  $77^{\circ} 2' 48'' W.$  and  $122^{\circ} 25' W.$  respectively. When it is noon at San Francisco, what is the time at Washington? When it is 2 P.M. at Washington, what is the time at San Francisco?

4. If a telegram is sent at 11:30 A.M. from Kansas City in longitude  $94^{\circ} 37' 40'' W.$  to Boston in longitude  $71^{\circ} 3' 51'' W.,$  allowing 20 minutes of time for transmission, when will it reach its destination?

5. A cablegram, sent from New York in longitude  $74^{\circ} 0' 3'' W.,$  was received in Paris in longitude  $2^{\circ} 20' 22\frac{1}{2}'' E.$  at 1:30 P.M. after a delay of 25 minutes in transmission. When was it sent from New York?

6. The difference in time between two cities is 1 hour, 37 minutes, and 20 seconds. What is the difference in longitude?

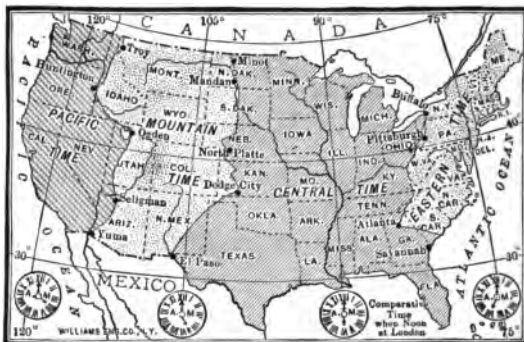
7. At 8:40 A.M. a ship in longitude  $17^{\circ} 20' W$ . sends a wireless message which is received by another ship at 8:45 A.M. Find the longitude of the second ship.

8. A man arriving in New York found that his watch, set by local time at his starting point, was 1 hour and 26 minutes slower than New York time. From what longitude did he come?

### STANDARD TIME

**135.** On account of the inconvenience of reckoning the time of a place strictly in accordance with its meridian, most countries have adopted a system of standard time. In the United States four time belts, each 15 degrees apart, have been established. All points lying in the same belt use exactly the same time, and the difference in time between places located in different belts is an integral number of hours. These belts, or sections, are known as Eastern, Central, Mountain, and Pacific; the central meridian of each section being  $75^{\circ}$ ,  $90^{\circ}$ ,  $105^{\circ}$ , and  $120^{\circ}$ . By this plan when it is noon in Washington, it is 11 A.M. in Chicago, 10 A.M. in Denver, and 9 A.M. in San Francisco.

While the time meridians are exactly  $15^{\circ}$  apart, the belts using the several meridian times vary to suit the convenience of the railroads. They prefer that the changes be made at some city on the road, and this leads to the irregularities in division lines.



STANDARD TIME MAP OF THE UNITED STATES.

### Oral Exercise

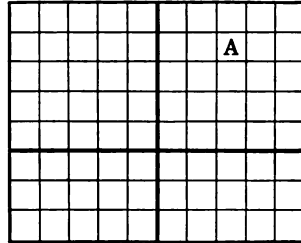
**136.** What is the difference in standard time between:

1. Boston and New Orleans?
2. Washington and Kansas City?
3. Chicago and Salt Lake City?
4. Cincinnati and San Francisco?
5. At what city in the United States near the 105th meridian is there no mountain time?
6. What is the difference between Standard Time and Sun Time at El Paso, Texas?
7. At San Francisco?
8. When it is noon in Washington by sun time, what is the correct standard time?

## GOVERNMENT LAND MEASURE

**137.** Most of the public lands of the United States are surveyed by selecting a north-and-south line called the **principal meridian**, and an east-and-west line called the **base line**. On each side of the principal meridian and at distances of six miles are north-and-south lines called **range lines**, which divide the land into strips six miles wide called **ranges**.

By east-and-west lines parallel to the base line the ranges are divided into townships six miles square. A township is designated by giving its number and direction from the **base line**, the number and position of its range, and the number of the **principal meridian**. Thus: township (A) in the figure is Township 4 north, Range 3 east of the principal meridian.



6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

The townships are divided into 36 sections numbered as shown in the figure. The sections are divided into halves and quarters; the quarters into halves and quarters; and so on.

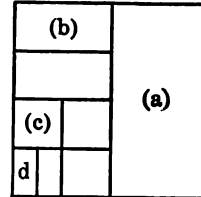
Note the description of the following tracts:

(a) E.  $\frac{1}{2}$  Sec. 25, T. 4 N. 3 E.

(b) N.  $\frac{1}{2}$  N. W.  $\frac{1}{4}$  Sec. 25, T.  
4 N. 3 E.

(c) N. W.  $\frac{1}{4}$  S. W.  $\frac{1}{4}$  Sec. 25, etc.

(d) W.  $\frac{1}{2}$  S. W.  $\frac{1}{4}$  S. W.  $\frac{1}{4}$  Sec.  
25, etc.



### Written Exercise

**138.** Draw a three-inch square representing a section, marking in it the following tracts, and tell how many acres each contains.

1. The N. W.  $\frac{1}{4}$  of the N. W.  $\frac{1}{4}$ .
2. The S.  $\frac{1}{2}$  of the N. E.  $\frac{1}{4}$ .
3. The N.  $\frac{1}{2}$  of the N. E.  $\frac{1}{4}$  of the S. W.  $\frac{1}{4}$ .
4. The S. W.  $\frac{1}{4}$  of the S. E.  $\frac{1}{4}$  of the N. W.  $\frac{1}{4}$  of the S. E.  $\frac{1}{4}$ .
5. The S.  $\frac{1}{2}$  of the N. W.  $\frac{1}{2}$  of the S. E.  $\frac{1}{4}$ .
6. The S.  $\frac{1}{2}$  of the S. E.  $\frac{1}{4}$  of the N. E.  $\frac{1}{4}$  of the S. E.  $\frac{1}{4}$ .

## REVIEW PROBLEMS

**139.** 1. There are 11 trees a rod apart along the end of a field, 17 along the side. How many acres in the field? Illustrate by drawing.

2. Abraham Lincoln was born February 12, 1809, and died April 14, 1865. How old was he when he died?

3. How many days from March 15 to September 30?

4. A boy can dig 18 bushels of potatoes in a day and he can pick up 45 bushels in a day. How many bushels can he dig and pick up in three days?

5. A drover bought 247 sheep at \$5 each; it cost him \$150 to get them to market; and 8 sheep died on the way. After selling the remainder for \$6.75 per head, how much did he gain?

6. Which is more economical to buy, a farm wagon for \$52 that will last 8 years, or a \$68 wagon that will last 11 years?

7. Allowing for  $1\frac{1}{2}$  inches overlap, how much sheet metal is required for the lateral surface of a hollow cylinder of 14 feet length and  $3\frac{1}{4}$  in. radius of base?

8. The weight of an iron bar 2 feet long, 3 inches wide, and 1 inch thick is 20 pounds. What is the weight of a bar  $7\frac{1}{4}$  feet long,  $4\frac{1}{2}$  inches wide, and  $3\frac{1}{2}$  inches thick?

9. A man's assets are \$3000, his liabilities \$4000. How much can he pay on the dollar?

10. A bankrupt pays  $37\frac{1}{2}\%$  on the dollar. How much will be lost by a creditor whose bill is \$750?

11. What will it cost for the material for a fence around a square farm containing 160 acres, if the fence costs 36¢ per rod for woven wire, the posts 18¢ apiece put in a rod apart, and a barb wire placed along the top of the fence requiring 480 pounds at \$2.75 per hundred?

12. A farm hand is hired on April 3 for  $3\frac{1}{2}$  months. When will his time expire?

13. A man hauled 139 loads of gravel for a road at \$1.35 per load. He paid a boy 15¢ a load for helping him with 91 loads. If it took 58 days to do the work, how much did he average per day?

14. What will 7260 pounds of wheat bring at \$1.08 per bushel?

15. A farmer takes six loads of hay to market. They weigh 2167, 2398, 2257, 2156, 2566, and 2750 pounds. What did he receive at \$18 per ton?

16. A farmer's wife sold a grocer 18 dozen eggs at 23¢ per dozen and 17 pounds of butter at 24¢

per pound. She received in payment 14 pounds of sugar at  $6\frac{1}{2}\text{¢}$  per pound, 3 pounds of coffee at  $37\text{¢}$  per pound, and cash for the rest. How much money did she receive?

17. What is the value of 6950 pounds of hay at \$16.50 per ton?

18. With corn at  $57\text{¢}$  per bushel (70 lb.), what is it per cwt.?

19. How many acres in a farm one mile long and 228 rods wide?

20. A ton of coal lasts a family 14 days on the average. What will their coal cost from October 1 to April 1 at \$6.25 per ton?

21. If 1000 laths cover 70 square yards of surface and 11 pounds of lath nails are required to put them on, what will it cost to lath the walls and ceiling of a community building 48 ft. by 36 ft. by 18 ft. high at \$2 per M for the lath,  $6\frac{1}{2}\text{¢}$  per pound for the nails, and  $3\frac{1}{2}\text{¢}$  per square yard for the labor?

22. How many cubic feet of earth must be removed in digging a cistern 8 feet in diameter and 14 feet deep?

23. How many bushels of wheat in a bin 12 ft. by 9 ft. by 6 ft.?

24. If a binder cuts a swath 8 feet wide, how many acres will be cut over by 10 swaths around a field 80 rods by 40 rods?



25. What will it cost to shingle a barn, each side of the roof of which is 70 ft. by 30 ft.? The shingles are laid  $4\frac{1}{2}$  inches to the weather, cost \$1.25 per bunch; and the labor for putting them on is \$1.15 per square.

26. If 1000 shingles are required for a square of roofing when laid 4 inches to the weather, how many will be required for a square of roofing if laid 5 inches to the weather? When laid  $4\frac{1}{2}$  inches to the weather? When laid  $3\frac{1}{2}$  inches to the weather?

27. Find the cost of digging a drain 48 rods long, 3 feet deep,  $3\frac{1}{2}$  feet wide at the top, and  $2\frac{1}{2}$  feet wide at the bottom, at 7¢ per cubic yard.

28. Which will carry the greater amount of water, two 3-inch tile or one 4-inch?

29. How many cubic yards of concrete are required to make a semicircular walk, 4 feet 6 inches wide, 48 feet long on the longer side, and 4 inches thick?

30. What will it cost to paint a land roller, at 27¢ per square yard, if it is  $3\frac{1}{2}$  feet in diameter and 14 feet long?

31. What will it cost to build the foundation wall for a house 28 ft. by 36 ft., if a cellar is under the entire house and the wall is  $7\frac{1}{2}$  feet high and 9 inches thick? A 1 : 3 : 6 cement mixture is used with the cement costing 45¢ per sack, and the other material 75¢ per square yard.

32. A field in the shape of a trapezoid has one of the parallel sides  $\frac{3}{4}$  of a mile long, the other  $\frac{1}{4}$  mile long. It is 60 rods wide. How many acres in the field?

33. A silo with staves 2 inches thick is 12 feet in diameter, inside measurements, and 30 feet high. What will it cost to creosote the inside and outside at 2¢ per square yard for labor?

34. A farmer builds a barn 80 by 36 feet. It is 32 feet to the eaves and 16 feet more to the comb. How many board feet are needed for the sides and ends? The roof is 25 by 84 feet on each side. How many shingles will be needed if they are laid 4 inches to the weather?

35. What fractional part of a mile is 2 yd. 1 ft. 4 in.?

36. A box car is 36 feet long, 8 feet wide, and  $7\frac{1}{2}$  feet high. If there are 66,000 pounds of wheat in the car, how deep is the wheat?

37. Find the weight of the wheat that will fill a bin 8 ft. by 6 ft. by 5 ft.

38. What is the cost to dig and wall a cellar 36 ft. by 32 ft., the excavation to be 6 feet deep and the wall to extend 2 feet above the ground? The wall is to be 18 inches thick and the stone and mason work costs \$3.60 per perch, and the excavating 60¢ per cubic yard.

39. If the wall in problem 38 is three bricks thick, what would be the cost at \$ 8.50 per M ?

40. How many cubic feet are there in a stick of timber 32 feet long, 9 inches thick, 12 inches wide at one end and 7 inches wide at the other ?

41. What are the contents of a mow of alfalfa hay 44 feet long by 24 feet wide, and 16 feet deep, allowing 512 cubic feet for a ton ?

42. A man bought 33 acres of land at \$ 225 per acre. He laid it out in lots 4 rods by 10 rods and sold them at \$ 100 apiece. How much did he gain by the transaction ?

43. What fractional part of a bushel is  $\frac{3}{8}$  of a quart ?

44. Find the cost of a load of hay weighing 2863 pounds at \$ 9.50 per ton.

45. A man will dig and load into a wagon or wheelbarrow 12 cubic yards of earth in 9 hours. If his time is worth 25¢ per hour, what will it cost to dig a cellar 24 ft. by 32 ft. by 7 ft. ?

46. A set of boilers at the Kansas State Agricultural College requires about 600 gallons of water per hour. Compute the size of a feed water pipe required to carry the water if the average velocity of the water in the pipe is 245 feet per minute (use  $\pi = 3\frac{1}{4}$ ).

47. A steam pump delivers 2.35 gallons of water per stroke and runs 48 strokes per minute. How many gallons will it deliver in an hour ?

## PERCENTAGE

### Study Exercise

**140.** We have seen in the study of common fractions and decimals that the decimal has many advantages in ease of operations over the common fraction. **Percentage** is very closely related to the decimal fraction, and in fact may be considered as a development of the decimal especially adapted to business and to comparisons of data in the scientific world. Instead of using all of the denominations that are used in decimals, only hundredths is used; hence, percentage is not a new subject but a further development of decimals in which hundredths alone is considered. **Per cent** means by the hundredths.

An example will make the meaning clear.

**EXAMPLE:** A careful examination of one pound of alfalfa seed showed that  $\frac{1}{4}$  of a pound was weed seed,  $\frac{1}{10}$  of a pound dirt, and the rest good seed. How many hundredths, or how many per cent, of each was found?

We see at once that  $\frac{1}{4}$  of the pound was weed seed,  $\frac{1}{10}$  was dirt, and  $\frac{13}{20}$  was good seed. The fractions  $\frac{1}{4}$ ,  $\frac{1}{10}$ ,  $\frac{13}{20}$  cannot easily be compared unless they are reduced to the same denominator. This comparison can more easily be made if 100 is

used; *i.e.* if the pound is considered as being composed of 100 parts. Hence, the amount of weed seed may be represented by  $\frac{1}{4}$ ,  $\frac{25}{100}$ , .25, or 25 %; the amount of dirt by  $\frac{1}{10}$ ,  $\frac{10}{100}$ , .10, or 10 %; and the amount of real seed by  $\frac{13}{20}$ ,  $\frac{65}{100}$ , .65, or 65 %.

### Oral Exercise

**141.** Express the following per cents as decimals, and as common fractions in their lowest terms :

- |                      |                        |                       |                        |
|----------------------|------------------------|-----------------------|------------------------|
| 1. 3 %.              | 7. .4 %.               | 13. .35 %.            | 19. $\frac{2}{3}$ %.   |
| 2. 15 %.             | 8. 62 %.               | 14. 9.05 %.           | 20. $\frac{1}{5}$ %.   |
| 3. 6 %.              | 9. .1 %.               | 15. 175.              | 21. .003 %.            |
| 4. 65 %.             | 10. $87\frac{1}{2}$ %. | 16. $6\frac{3}{4}$ %. | 22. $58\frac{1}{3}$ %. |
| 5. $4\frac{1}{2}$ %. | 11. 125 %.             | 17. .007 %.           | 23. $66\frac{2}{3}$ %. |
| 6. 37 %.             | 12. 3.5 %.             | 18. $\frac{1}{6}$ %.  | 24. $6\frac{2}{3}$ %.  |

### Study Exercise

**142.** The number of which a certain per cent, or hundredths, is to be taken is called the **base**.

The result obtained by taking a certain per cent of a number is called the **percentage**.

The number indicating the number of hundredths of the base to be taken is called the **rate**.

The **amount** is the base plus the percentage. The **difference** is the base less the percentage.

Three cases of problems occur in percentage.

**Case I.** Problems in which the base and rate are given, to find the percentage.

**Case II.** Those with the base and percentage given, to find the rate.

**Case III.** Those with the rate and percentage given, to find the base.

### Study Exercise. Case I

**143.** Given the base and rate, to find the percentage. The percentage equals the base times the rate (expressed as hundredths).

**Formula for Case I:**  $P = b \times r$ .

1. Find 23 % of 576 pounds.

**Process**  
 576 lb.  
 .23  
 ———  
 17 28  
 115 2  
 ———  
 132.48 lb.    *Ans.*

**Explanation:** Apply the formula  $P = b \times r$ . 576 pounds is the base and 23 % is the rate. Since 23 % of a number is .23 of it, 23 % of 576 pounds =  $.23 \times 576$  pounds = 132.48 pounds.

### Oral Exercise

**144.** 1. Find 2, 5, 8, 12, 20, 40, 50, and 60 per cent of \$120.

2. Find 20 % of 8, 12, 20, 40, 56, 80, 100, 120.

3. Find 1 % and then  $\frac{1}{2}$  % of 110, 120, 200, 250, 90, 8, 4, and  $\frac{1}{4}$ .

4. What is  $83\frac{1}{3}$  % of \$25? of \$72? of \$84?

5. What is 75 % of \$40? of \$56? of \$64?

6. What is 125 % of 60 bu.? 150 % of 75 bu.?

7. What is  $37\frac{1}{2}$  % of 80?  $62\frac{1}{2}$  % of 32?  $166\frac{2}{3}$  % of 52?

**Written Exercise**

- 145.** 1. What is 7% of \$12.50? \$25.85? \$65.70? and \$254.75?
2. What is 24% of a section of land?
3. What is  $\frac{1}{4}$ % of 6278 pounds of milk?
4. Find  $1\frac{1}{4}$ % of \$6754.25.
5. Find  $\frac{3}{8}$ % of \$5943.
6. What is 127% of \$6457?
7. What is  $133\frac{1}{3}$ % of 6498 bushels?
8. What is .24% of 7842.3 pounds of milk?

**Written Problems**

- 146.** 1. If 10% of the weight of wheat is water and the rest dry matter, how much water and how much dry matter in 30 bushels of wheat?
2. If a ton of coal has 12.19% moisture and if 6.74% of the dry coal is ash, how many pounds of ash does the ton contain?
3. If cottonseed meal contains 42% protein, 8.67% fat, and 6.32% fiber, how many pounds of each ingredient are there in a ton?
4. A certain poultry mash and meal contains 22.94% protein, 5.22% fat, and 5.40% fiber. Find the amount of each in 500 pounds.
5. If a dozen eggs weigh 22 ounces and contain 13.4% protein and 10.5% fat, how many ounces of protein and fat in 10 dozen eggs?

6. If sirloin steak contains 18.9 % protein and 18.5 % fat, how many ounces of protein and fat in 10 pounds of steak?

7. If a man eats 2 eggs and 3 ounces of steak, how many ounces of protein and fat does he eat?

8. An egg weighs on the average 1.88 ounces, of which 56.96 % is white, 33.18 % yolk, and the rest water. What is the weight of each of the constituents of an egg?

9. To secure a yield of corn of 60 bushels per acre about 30,000 pounds of green corn must be produced. It is estimated that 60,000 pounds of water are required for every 1000 pounds of green corn. How many inches of rainfall are required if all the water is available? If only about 50 % of the rainfall is available for the use of the crop, what would be the smallest possible rainfall necessary to produce 60 bushels of corn per acre?

#### Study Exercise. Case II

147. Base and percentage given, to find the rate. To find the rate, divide the percentage by the base. The result of division will be a decimal, and this may then be expressed as per cent.

The formula for Case II is  $R = \frac{p}{b}$ .

1. A farmer raised 475 bushels of wheat, of which he sold 228 bu. What per cent of the wheat did he sell?



Process	Explanation: Apply the formula $R = \frac{p}{b}$ .
$.48 = 48\% \text{ } Ans.$ $\begin{array}{r} 475 \overline{)228.00} \\ \underline{1900} \\ 3800 \\ \underline{3800} \end{array}$	$228 \text{ bu. is the percentage and } 475 \text{ bu. is the base. Dividing the percentage by the base we get } .48 \text{ or } 48\% ; \text{ that is, } 228 \text{ bu. is } 48\% \text{ of } 475 \text{ bu.}$

### Oral Exercise

**148.** 1. What per cent of 16 is 8? Of 15 is 3? Of 16 is 4?

2. What per cent of 24 is 18? Of 30 is 25? Of 40 is 16?

3. 4 is what % of 5? 6 of 8? 10 of 15? 5 of 3?

4. \$120 is what % of \$160? 60 rods is what % of a mile?

5.  $\frac{1}{4}$  is what % of  $\frac{1}{2}$ ? of  $\frac{3}{8}$ ? of  $\frac{2}{3}$ ? of 2?

6. What % more than 200 is 250? 240 is 300?

7. What % less than 75 is 50? 60 is 40?

### Written Exercise

**149.** 1. What per cent of 6714 is 78? Of 98 is 64?

2. What per cent of \$12.50 is \$3?

3. What per cent of \$7487 is \$986?

4. What per cent of 72 feet is 6.1 feet?

5. What per cent of  $\frac{2}{3}$  is  $\frac{1}{2}$ ?

6. What per cent of 484 is 86?

7. What per cent of 45 is  $\frac{6}{7}$ ?

8. What per cent of  $\frac{3}{4}$  is .45?
9. What per cent of 24 is 9.76?
10. What per cent of 27.3 is 8.57?
11. What per cent of 6872 is 178.56?

### Written Problems

150. 1. In a field of undrained land a farmer is able to raise a crop of oats averaging 27 bushels per acre. By tiling the land the yield is increased  $17\frac{1}{2}$  bushels. What is the per cent of gain?

2. On ten acres of ground a farmer raises 184 tons and 600 pounds of sugar beets for which he receives \$5 a ton. If he spends \$200 for labor and the land is worth \$150 an acre, what per cent of the value of the land is his net profit on the crop?

3. The average yield of wheat in Kansas is 13.1 bushels per acre, in Great Britain 31 bushels. What per cent greater is the yield of wheat in Great Britain than in Kansas?

4. A merchant failed owing \$18,500, with assets of \$7200. What per cent of his debts could he pay? How much on the dollar?

5. Of 1000 pounds of green corn about 200 pounds are dry matter. If the dry matter is burned, the ashes will weigh about 12 pounds. What per cent of green corn is ash? What per cent is organic matter; *i.e.* passes off in the form of smoke?

6. The entire number of cattle on the farms and ranges of the United States was 53 millions in 1890, 68 millions in 1900, and 69 millions in 1910. Find the per cent of increase for each decade.

7. The acreage and yield of sugar beets in Kansas for 1911 was 4963 acres and 27,256 tons, and in 1912, 8903 acres and 88,842 tons, respectively. What was the per cent of increase in yield per acre?

8. The composition of a certain bronze alloy is 53 parts by weight of copper,  $22\frac{1}{2}$  of nickel, 22 of zinc, 5 of tin,  $\frac{3}{4}$  of bismuth, and  $\frac{3}{4}$  of aluminum. Express these as per cents, and find the weight of each material required to make 1748 pounds of alloy.

9. In a winter steer feeding experiment, the following daily ration for each animal was used: 15.40 pounds of shelled corn, 2.75 pounds of cottonseed meal, 5.81 pounds of clover hay, and 16.03 pounds of corn silage. Each kind of feed was what per cent of the daily ration?

10. Determine the percentage standing of the national league baseball clubs for a recent year by filling the proper column of the following table:

TEAM	WON	LOST	PER CENT	TEAM	WON	LOST	PER CENT
Chicago . .	99	55	—	Cincinnati.	73	81	—
New York . .	98	56	—	Boston . .	63	91	—
Pittsburgh .	98	56	—	Brooklyn .	53	101	—
Philadelphia	83	71	—	St. Louis .	49	105	—

**Study Exercise, Case III**

**151.** Percentage and rate given, to find the base. To find the base when the percentage and rate are given, divide the percentage by the rate, expressed as a decimal.

The formula for Case III is  $B = \frac{p}{r}$ .

1. If a farm rents for \$450, or 6% of its value, what is its value?

<b>Process</b> $\begin{array}{r} .06 \overline{) \$450.00} \\ \underline{\$7500} \end{array}$	<b>Explanation:</b> $B = \frac{p}{r}$ . \$450 is the percentage and 6% is the rate. Dividing the percentage by the rate we obtain the base, or value; hence $\$450 \div .06 = \$7500$ , value of the farm.
--	--

**Oral Exercise**

- 152.** 1. 50 is 25% of what number?
2. 16 is  $33\frac{1}{3}\%$  of what number?
3. 2 is  $\frac{1}{2}\%$  of what number?
4. 10 is .3% of what number?
5. \$2.50 is  $12\frac{1}{2}\%$  of how many dollars?
6. 40 gal. is  $66\frac{2}{3}\%$  of how many gallons?
7. 8 ft. 8 in. is  $83\frac{1}{3}\%$  of what?
8. 3 bu. 4 pk. is 40% of what?

**Written Exercise**

- 153.** 1. 12 is 20% of what number?
2. 16 is 25% of what number?
3. 56 is  $33\frac{1}{3}\%$  of what number?

4.  $\frac{1}{2}$  is 40 % of what number ?
5. 74 is 75 % of what number ?
6. 93 is 49 % of what number ?
7. 47 is  $\frac{3}{4}$  % of what number ?
8. 96 is .5 % of what number ?
9. 187 is 125 % of what number ?
10. 457 is  $166\frac{2}{3}$  % of what number ?

### Written Problems

**154.** 1. If a farm rents for \$850, which is 4 % of its value, what is its value ?

2. I sold 148 bushels of wheat, which was 37 % of what I raised. How much did I raise ?

3. During a certain year of the tick-fever scourge 161,000 cattle of Mississippi, or 18.5 %, died of the disease. Find the number of cattle in the state for that year.

4. If the ore in a mine yields  $\frac{2}{3}$  % of 1 % of pure gold, how many tons of ore must be taken out to obtain 8 pounds of gold ?

5. A grocer bought potatoes at 48¢ per bushel and marked them so as to gain 25 %, but sold them at a reduction of  $12\frac{1}{2}$  % from the marked price. If he gained \$56.25, how many bushels had he ?

6. A contractor estimates the actual cost to him of paving a certain street at \$825 per block. What should be the complete estimate on the

basis of 6% of the above amount for superintending and 10% on the cost, including superintending, for profit?

7. In an experiment to increase the amount of butter fat in milk by liberal feeding, it was found that the average weekly production of 4.18 pounds of butter fat per single cow of a dairy herd was increased 55%, and that the food cost of 18¢ per day was increased  $16\frac{2}{3}\%$ . If butter fat yields  $\frac{5}{8}$  of its weight in butter, find the increased weekly profit from the liberal feeding with butter at 28¢ per pound.

### GROUP PROBLEMS IN PERCENTAGE

#### Group I. Seeds

155. 1. Of 51 samples of clover seed examined by the U. S. Department of Agriculture 3 were heavily adulterated with black medic, 10 were free from dodder, and of these 2 were of low vitality. What per cent were entirely fit for seed? What per cent were of low vitality?

2. In the vitality test 86.6% was the average for the 51 samples. What was the average number of pounds of good seed to the bushel?

3. If clover seed is \$12 per bushel, what is the actual cost per bushel of good seed if 86.6% of the seed is good?

4. If the lowest test was 64.2%, what would be the actual cost per bushel of good seed at \$12 per bushel?

5. A vitality test on one sample of seed showed that 72% of it was good. Another sample tested showed that 89% of it was good. If the first sample was \$10 per bushel and the second \$14 per bushel, which would be the more expensive to buy for good seed?

6. If only 90% of the wheat required to sow 40 acres germinates, how many acres are seeded to grain that will not germinate?

7. If 8 out of every 10 grains of corn grow, what per cent of the seed is good?

8. The average loss of weight of corn in cribs at the Kansas station from November 1 to January 31 was 5.17%. What would be the loss from shrinkage on 1560 bushels of corn if kept until January 31? Which would be the more profitable, to sell the corn in November at 55¢ or keep it until January and sell it at 65¢ per bushel?

#### Group II. Dairy Problems

156. 1. If cream testing 25% sells at 60¢ per gallon, what should be the price per pound of butter if it takes  $\frac{1}{4}$  of a pound of butter fat to make one pound of butter?

2. If the butter is worth 30¢ per pound, what should cream testing 26% be worth per gallon?

3. If milk tests 5.3 % and 8 % is lost in skimming by the shallow-pan method, what is lost per year if a cow averages 25 pounds of milk per day?

4. What is the loss if the deep-pan method is used and only 3.2 % is lost?

5. What is the loss if a hand separator is used and only .3 % is lost?

6. A cow averages 20 pounds of milk daily for a year. What will be the value of the butter fat produced, if the milk tests 4.1 %, at 28¢ per pound?

7. In an experiment at the Wisconsin station with the dairy herd, it was found that each cow averaged for the year 8536 pounds of milk which yielded  $4\frac{1}{6}$  % of butter fat, which in turn was converted into butter,  $\frac{5}{8}$  of which was butter fat. With the cost of feed \$65.72, and butter worth  $27\frac{1}{2}$ ¢ per pound, what was the profit for each cow?

8. In a feeding test at the Illinois station the average milk production per cow for a period of six weeks was:

Lot I		Lot II	
Timothy	Alfalfa	Timothy	Alfalfa
1134 lb.	1247 lb.	829 lb.	1065 lb.

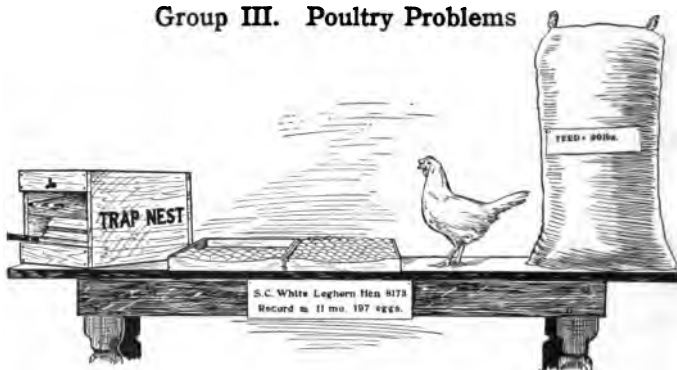
What was the per cent of increase in milk production gained in each case by feeding alfalfa hay?

9. During a three months' period one cow gives 1825 pounds of milk yielding 3.8 % of butter fat, and another gives 1460 pounds of milk yielding



3.4% of butter fat. The food cost of the first cow was \$5.40 per month and of the other 8% less. If the butter fat is converted into  $\frac{2}{3}$  of its weight in butter with butter at 26¢ per pound, which cow pays the more for the period and how much?

### Group III. Poultry Problems



**157. 1.** From 879 eggs set, 533 were hatched in incubators. What per cent of the number were hatched? (Oregon Experiment Station.)

**2.** From 279 eggs, hens hatched 219 chicks. What per cent of the eggs were hatched?

**3.** In Problems 1 and 2, 78.5% and 96.5% of the fertile eggs hatched. How many of the eggs in each case were fertile?

**4.** The mortality of the hen-hatched chicks raised in brooders was 10.8% in 4 weeks, and of the incubator-hatched chicks was 33.5%. How many of the chicks of Problem 2 were living at

the end of four weeks? How many of those of Problem 1?

5. The mortality of hen-hatched chicks brooded under hens was 2.2 % and of the incubator-hatched chicks under the same conditions of brooding was 49.2 %. What was the number living at the end of four weeks in each case given above?

6. In other tests the mortality was 46.5 % for incubator chicks brooded by hens and 58.4 % for those raised by brooders. What would be the number of survivors in each case given above?

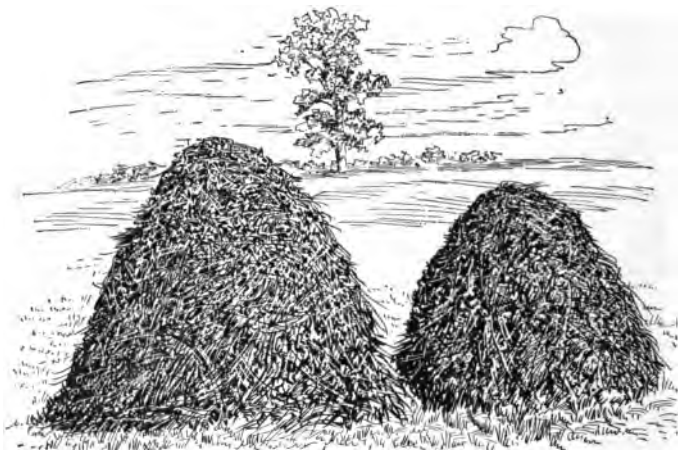
7. How much of each of the following feeds will a hen eat in a year if fed .175 pound of grain, .07 pound of ground bone, and .022 pound of alfalfa meal daily?

8. What will it cost to keep a hen a year if the grain is \$1.25 per hundred, the ground bone  $1\frac{1}{2}$ ¢ per pound, and the alfalfa meal \$10 per ton?

9. If eggs are worth 22¢ per dozen, how many eggs must a hen lay to pay for her feed for one year?

10. The average of a poultryman's flock of hens in 1899 was 76 eggs, and in 1906 by selecting and breeding it had increased to 134. What was the per cent of increase?

11. The hens of Kansas average 75 eggs per year. This is 34.25 % of the number the best hens lay. How many do the best hens lay?

**Group IV. Fertilizer Problems**

**158. 1.** A ton of average barnyard manure contains 10 pounds of nitrogen, 6 pounds of phosphoric acid, and 8 pounds of potash. What is the per cent of each in barnyard manure? What would be the value of five loads of manure weighing a ton each at the rate of 15¢ per pound for the nitrogen, 5¢ for the phosphoric acid, and 5¢ for the potash?

**2.** The amount of phosphoric acid and potash found in the five loads of Problem 1 is about 40% of the amount of each of these taken from the soil by a crop of corn yielding  $62\frac{1}{2}$  bushels and 5 tons of stalks. How many pounds are taken from the soil by the corn crop?

3. In a four years' series of experiments with potatoes at the New York station the yield per acre for the unfertilized plots was 160.1 bushels, and of the plots treated with 1000 pounds of fertilizer per acre, 184.5 bushels. Find the per cent of increase due to the fertilizer.

4. The following results show the effects of different fertilizers upon the yield of muskmelons at the Illinois station. No manure, 188 baskets per acre; manure broadcast, 400; manure broadcast and in the hills, 596; steamed bone in the hills, 305; manure and rock phosphate in the hills, 575. Each basket contains 16 pounds of fruit. Find the per cent of increased yield due to each fertilizer.

5. At the New York station the average annual yield of timothy hay per acre under various modes of treatment has been: No treatment, 3600 pounds per acre; 320 pounds of acid phosphate, 4233; 80 pounds of potash, 4490; 160 pounds of nitrate of soda, 4530; and 10 tons of manure, 5093. Find the per cent of increase in yield per acre due to each fertilizer. Also find the net profit from each treatment at the following scale of prices: acid phosphate, \$ 14 per ton; muriate of potash, \$ 40 per ton; nitrate of soda, \$ 50 per ton; manure, 50¢ per ton; hay, \$ 14.50 per ton.

6. A ton of fertilizer for corn land contains 45% cottonseed meal at \$ 30.50 per ton, with

93 % of the remaining portion consisting of acid phosphate at \$15.25 per ton and the rest muriate of potash at \$45.60 per ton, respectively. Find the cost of the fertilizer.

7. In a wheat-fertilizing experiment at the Indiana station the following results per acre were obtained :

	VALUE OF INCREASED YIELD AT 80¢ PER BUSHEL	FERTILIZER COST	PROFIT OR LOSS PER ACRE PER DOLLAR INVESTED
Nitrogen, phosphorus, potash	\$6.75	\$5.19	—
Phosphorus, potash . . . .	4.04	2.75	—
Nitrogen, potash . . . . .	2.65	3.38	—

Fill the blanks and, from the percentage results of the last column, note the relative value of the fertilizers.

8. What per cent of nitrogen, phosphoric acid, and potash will there be in a ton of fertilizer composed as follows: 700 pounds of acid phosphate, 800 pounds of bone meal, 500 pounds of muriate of potash with composition of the fertilizing materials taken as 14 % phosphoric acid, 3.8 % nitrogen plus 25.6 % phosphoric acid, and 50 % potash, respectively?

9. How many pounds of nitrogen, phosphoric acid, and potash will there be in a ton of fertilizer composed as follows: 1200 pounds of acid phosphate containing 14 % phosphoric acid; 300

pounds of potash, 50 % pure ; 250 pounds of bone meal, 3 % nitrogen and 22 % phosphoric acid ; and 250 pounds of filler ?

10. If cheese is 3.9 % nitrogen,  $.6\frac{1}{4}$  % phosphorus, and  $\frac{7}{12}$  % potash, how many pounds of each are sold in a ton of cheese ?

11. If butter is  $\frac{1}{4}$  % nitrogen,  $\frac{1}{2}$  % phosphoric acid, and  $\frac{1}{8}$  % potash, how many pounds of each are sold with a ton of butter ?

12. If beef is 2.5 % nitrogen, 1.9 % phosphoric acid, and  $\frac{3}{8}$  % potash, what is the number of pounds of each in a ton of beef ?

13. A bushel of wheat contains 2.1 % of nitrogen, 1.1 % phosphoric acid, and .6 % potash. How many pounds of each are removed from the farm with every ton of wheat sold ?

14. A bushel of corn contains 1.4 % of nitrogen, .5 % of phosphoric acid, and .5 % of potash. How many tons of each are removed from the farm with every ton of corn sold ?

15. In a ton of wheat straw there are about  $\frac{1}{2}$  % of nitrogen,  $\frac{1}{8}$  % of phosphoric acid, and  $\frac{3}{8}$  % potash. What would be the loss in pounds of fertilizing substances if the straw was sold ?

16. If an acre of land when manured yields  $11\frac{1}{2}$  bushels of wheat and when treated with manure and rock phosphate yields 15 bushels, what is the per cent of increase due to the use of the phosphate ?

17. The fertilizing value of average fresh manure is about \$ 2.25 per ton, and after leaching two or three months in heavy rains it is worth about \$ 1.50 per ton. What is the per cent of loss?

18. In a series of experiments on corn, wheat, oats, and potatoes it was found that one ton of fresh manure produced an average increase in crop value of \$ 2.96 and when exposed three months yielded an increase of \$ 2.15. Find the per cent of loss in fertilizing value.

#### Group V. Spraying Problems

159. 1. Two farmers plant an acre of potatoes each. One sprays for the blight and gets a yield of 200 bushels; the other does not spray and gets 85 bushels. What was the per cent of increase due to spraying?

2. In an experiment for control of apple blotch, the following table exhibits data and partial results:

BLOCK I

TREES SPRAYED	TOTAL YIELD	AFFECTED BY BLOTCH	PER CENT
No. 1	1331	38	—
No. 2	3464	62	—
No. 3	2551	80	—
No. 4	3227	83	—
Total	—	—	—
Averages	—	—	—

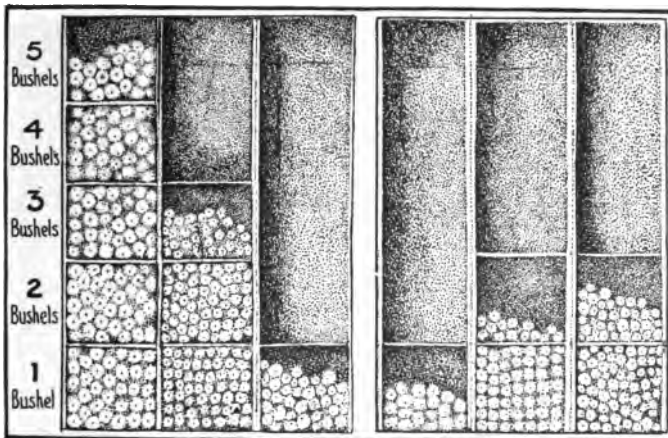
## BLOCK II

TREES UNSPRAYED	TOTAL YIELD	AFFECTED BY BLOTCH	PER CENT
No. 1	4287	288	—
No. 2	5858	969	—
No. 3	1742	201	—
No. 4	2182	171	—
No. 5	1467	182	—
Total	—	—	—
Averages	—	—	—

Fill the blanks and note the effect of spraying by comparison of the average per cents.

**SPRAYED****UNSPRAYED**

Ones Twos Culls      Ones Twos Culls



3. In an apple tree pruning experiment, the following results in fruit yield in bushels were



obtained: from an unpruned set of five trees, 2.37 bushels of fancy grade, 15.77 bushels of ones, 12 bushels of twos, 2.25 bushels of culls; from a pruned set of five trees in the same orchard 5.94 bushels of fancy grade, 15.25 bushels of ones, 4.05 bushels of twos, and 1.08 bushels of culls. Determine for each grade in each set of trees its per cent of the total yield, and thus note the effect of pruning by a comparison of the same grade in the two sets.

4. Under ordinary circumstances the average yield of merchantable apples can be increased about 4 bushels per tree. This gives a net profit of \$ 1.62 per tree. What is the per cent of profit if apples are worth 80¢ per bushel?

5. The average per cent of increase in Problem 4 was 37 % of the sprayed over the unsprayed. What was the original yield?

#### Group VI. Soils

160. 1. By separating a clay soil into its constituent parts, it is found that about .2 % is fine gravel, .3 % is coarse sand, .4 % is medium sand, 1.5 % is fine sand, 3.1 % is very fine sand, 58.2 % is silt, and 36.3 % is clay. What amount of each is found in a cubic foot of soil weighing 65 lb.?

2. The composition of sandy loam is as follows: 1.3 % fine gravel, 3.3 % coarse sand, 4.3 % medium sand, 17.5 % fine sand, 21.5 % very fine sand, 17.5 % silt, and 14.3 % clay. What amount

of each is found in a cubic foot of sandy loam weighing 87 pounds?

3. The composition of a silt loam is as follows: .8 % fine gravel, 5.1 % coarse sand, 4 % medium sand, 5 % fine sand, 6.3 % very fine sand, 60.7 % silt, and 18.1 % clay. Find the amount of each contained in a cubic foot of soil weighing 75 pounds.

4. An analysis of Minnesota prairie loam to determine the amount of plant food constituents found in the soil showed the following results: .16 % phosphoric acid, .83 % lime, .35 % magnesia, .43 % soda, and .4 % potash. Find the number of pounds of each of these found in a one-acre foot of soil, if one cubic foot of soil weighs 80 lb.

5. An analysis of Ohio silt loam to determine the amounts of plant food gave the following results: .09 % phosphoric acid, .18 % lime, .5 % magnesia, .29 % soda, and .21 % potash. Find in thousand pounds the amounts of each of these in one-acre foot of soil whose estimated weight is 3.5 million pounds.

6. Determine the maximum water capacity of the various soils listed in the following table:

NAME OF SOIL	TOTAL WEIGHT PER CUBIC FOOT	WEIGHT OF WATER IN 1 CU. FT.	% OF WATER AT SATURATION
Coarse sand . . .	81	32.0	
Light silt loam . .	83	31.5	
Clay . . . . .	68	37.0	
Humus . . . . .	15	50.0	

## GAIN AND LOSS

**161.** The one fundamental thing to be remembered in figuring gain and loss in a business transaction, is the fact that **the gain or loss is always reckoned on the cost or the sum invested.** There is a very close relation between the terms of profit and loss and those of percentage. The **cost** is the base, the **per cent of gain or loss** is the rate, the **gain or loss** is the percentage, and the **selling price** is the amount or difference.

**Formulas :**  $\text{Cost} \times \text{rate} = \text{gain or loss, or } P = br.$

$\text{Gain or loss} \div \text{cost} = \text{rate, or } R = \frac{p}{b}.$

$\text{Gain or loss} \div \text{rate} = \text{cost, or } B = \frac{p}{r}.$

$\text{Cost} + \text{gain or loss} = \text{selling price.}$

If one formula is given, can you develop the others? Show how to do it.

### Oral Exercise

**162. 1.** Goods costing \$212.25 were sold at a profit of  $33\frac{1}{3}\%$ . What was the profit?

**2.** A horse costing \$150 was sold for \$180. What was the per cent of gain?

3. In order to gain 10 %, at what price must I sell a horse which cost \$ 120 ?
4. A farm sold for \$7150 at a profit of 10 %. What was the cost?
5. On account of a delay in shipping, plums that cost \$1 a crate were sold at 80¢. What was the per cent of loss ?
6. Butter that cost 30¢ a pound was sold for 33¢. What was the per cent of profit?

**Written Problems**

163. 1. A man bought a horse for \$180 and sold it at a profit of 18 %. What was the selling price and what was the profit?
2. A farmer bought 100 sheep at \$5 per head. From these he raises 96 lambs worth \$5 each. If it costs \$2.90 each to feed the sheep a year, what is the per cent of profit on the original investment ?
3. A hot-water heating plant for an eight-room house will cost about \$480. A hot-air heating system can be installed for \$175. If the better equipment saves 3 tons of coal worth \$ 7.25 per ton each year, what per cent is realized yearly on the extra amount invested ?
4. If a house is sold for  $\frac{3}{4}$  its cost, what is the loss per cent ?

5. A dealer buys apples at \$2.50 per barrel (3 bu.) and retails them at 30¢ per peck. Find his gain or loss on 40 barrels allowing 12% for loss by decay.

6. A merchant makes a retail profit of 25%. If he sells at wholesale for 10% discount from the retail prices, what per cent profit does he make?

7. A renter raises corn on 38 acres of \$50 per acre land. With a yield of 60 bushels per acre at 45¢ per bushel, an annual rental of  $4\frac{1}{2}\%$  of the farm value, and a cost of crop production amounting to \$5.50 per acre, how much profit does he make? What is the per cent of profit?

8. With the conditions of Problem 7, the crop weighing 80 tons, and the cost of marketing \$3 per ton, find the profit and the per cent of profit.

9. What per cent does a grocer gain by using a false weight of  $15\frac{1}{2}$  ounces for a pound? What per cent does the customer lose?

10. A quantity of oats was sold in succession by three dealers, each of whom made a profit of 4%. The last dealer received \$2756. How much did it cost the first?

11. A house is valued at \$4500 and rents at \$30 per month. The yearly repairs amount to \$60, and the taxes and insurance to \$42.50. What per cent on the investment does the property pay?

12. A farm worth \$5000 with buildings valued at \$1200, stock and machinery at \$1500, yields

an annual return of \$1800. Counting the rise in land value at 3 %, depreciation and repairs of buildings at 5 %, depreciation of stock and machinery at 6 %, taxes and insurance at \$70, labor at \$300, other expenses at \$250, what is the amount of gain? the per cent of gain?

13. A man bought a tract of land for \$3000 with a frontage of 20 rods and depth of 150 feet and cut it up into residence lots having a 65-foot front for the corner lots and a 50-foot front for each of the others. One year later he sold the corner lots for \$1200 each and the others at \$1000 each, having in the meantime paid an average of \$20 a lot for taxes and \$4 a running front foot for sidewalks and paving. What was the gain? The per cent of gain?

14. A man sold two houses for \$4000 each. On one he gained 25 %, and on the other he lost 25 %. What was the gain or loss on the whole transaction? What was the per cent of gain or loss?

15. The average annual depreciation of the first cost of a mower costing \$45 is 7.8 % ; of a grain binder costing \$145 is 7.91 % ; of a corn binder costing \$125 is 10.03 %. What is the average annual depreciation of each?

16. A manure spreader cost \$125. It has been used 7 years and is now valued at \$33. What is the annual per cent of depreciation based upon the first cost?

## COMMISSION

### Study Exercise

**164.** A person who buys or sells goods or who transacts business for another person is called a **commission merchant or agent**.

The agent's pay is usually reckoned at a certain per cent of the amount of the transaction and is called the **commission**.

The total amount received by the agent for the sales is the **gross proceeds**.

The **prime cost** is the actual cost of the articles.

The sum left after the commission has been paid is called the **net proceeds**.

The principles of percentage applied here may be expressed in formulas as follows :

**Formulas:** Commission = gross proceeds or prime cost  $\times$  rate of commission,

$$P = br.$$

Rate of commission = commission  $\div$  gross proceeds or prime cost,

$$R = \frac{p}{b}.$$

Gross proceeds or prime cost = commission  $\div$  rate of commission,

$$B = \frac{p}{r}.$$

**Oral Exercise**

- 165.** 1. The gross proceeds of a sale are \$ 360, rate 3 %. What is the commission ?
2. The prime cost is \$ 1250, rate  $2\frac{1}{2}$  %. What is the commission ?
3. The commission is \$ 9.50, gross proceeds \$ 380. What is the rate ?
4. The commission is \$ 18, the prime cost \$ 1200. What is the rate ?
5. The commission is \$ 20 and the rate  $2\frac{3}{4}$  %. What is the prime cost ?
6. The commission is \$ 12.80 and the rate  $\frac{3}{8}$  %. What are the gross proceeds ?

**Written Problems**

- 166.** 1. If I send a coop of 2 dozen young chickens, averaging 3 pounds each, to St. Louis and a commission firm sells them at 29¢ per pound, charging a commission of 8 %, and paying 50¢ express, what do I receive per pound for the chickens ?
2. A fruit grower sends 75 barrels of apples to a commission merchant, who sells them at \$ 2.50 per barrel. His commission is 5 % and the freight is 35¢ per barrel. What will the fruit grower receive per barrel for the apples ?
3. A dairyman sent his city agent during a certain month 975 pounds of butter. If the agent's commission was  $2\frac{1}{2}$  %, the delivery charges \$ 10.35, selling



price per pound 34¢, what was the amount the dairyman received per pound for his butter?

4. A city merchant sent his agent in Missouri \$1200 with which to buy apples at 65¢ per barrel and pay his commission of  $3\frac{1}{2}\%$  and 6¢ per barrel for drayage. How many barrels did he buy?

5. A dairyman received \$715 as the net proceeds of a shipment of butter. If the agent's commission was 2%, storage and delivery charges \$20, how many pounds were sold at 30¢ per pound? What was the agent's commission?

6. A farmer ships three cars of baled alfalfa hay, each car containing 12 tons, to a commission merchant in Kansas City, who sells it for \$14.50 per ton. After paying 50¢ per car switching charges, 50¢ per car inspection charges, \$12 freight, and receiving 50¢ per ton commission for selling, what will be the net proceeds for the farmer?

7. What per cent of the gross receipts are the charges connected with the selling of the hay in Problem 6?

8. If the commission for selling the hay in Problem 6 be increased 50%, what will be the net proceeds?

9. A live stock dealer ships a bunch of 69 hogs, weighing 16,580 pounds, to Kansas City, and the commission man, after deducting 80 pounds for shrinkage, sells the lot for \$6.35 per hundred.

After paying \$ 25.50 for freight, including feed on the road, \$ 4.14 for yardage, for 2 bushels of corn at \$ 1.10 per bushel, and charging \$ 8 for selling, what is the amount of the check returned to the shipper ?

10. A stockman ships a carload of 26 steers, averaging 1520 pounds each, to Kansas City, and the commission dealer sells them at \$ 8.75 per hundred. After paying \$ 21 for freight, including feed on the road, \$ 4.70 for yardage, for 400 pounds of hay at \$ 15 per ton, for 200 pounds of corn at \$ 1 per bushel, and charging 60¢ a head for selling, find the net amount sent to the shipper.

11. A live stock man ships a carload of 63 hogs, weighing 325 pounds each, to Chicago; and the commission merchant sells them for \$ 8.35 per hundred-weight. Find the amount of the check sent to the shipper after settlement of the following expense account: \$ 19.50 freight, including feed on the road, \$ 3.78 yardage, 3 bushels of corn at 90¢ per bushel, 20¢ inspection per head, 20¢ a head commission for selling.

12. The market quotation on apples for a certain day was \$ 3.65 a barrel. After receiving 275 barrels, a falling market made it necessary for the commission firm to sell them at \$ 3.45. If the freight was 15¢ a barrel, drayage 10¢ a barrel, and commission 5%, what was the loss in net proceeds due to the change in the market ?

## TAXES

**167.** Money levied by the government for its support is called a **tax**. Taxes are collected chiefly from two classes of property, — real estate and personal property. **Real estate** includes land with its improvements and buildings. **Personal property** refers to movable property, such as furniture, live stock, merchandise, money, notes, etc.

A **poll tax** is a tax laid upon each voter regardless of property owned. An **assessor** is a person who makes the valuation of property for purposes of taxation. **Tax rates** on real or personal property are usually expressed as a rate per cent or as a certain number of mills or cents on the dollar, and are based upon the assessed valuation.

Money raised by taxes is expended in the state for the maintenance of schools and other institutions under state control. In the counties money must be spent to build roads and bridges, to take care of the poor, and to provide for a great many other things. These expenses are met by the taxes collected. Besides the county expenses there are those of the township or the city, to which must also be added the school tax.

How are the expenses of the national government met?

Solutions of problems in taxes depend upon the principles of percentage.

The **assessed valuation** is the **base**.

The **rate of taxation** is the **rate**.

The **tax** is the **percentage**.

### Study Exercise

**168.** 1. The assessed valuation of a farm is \$6000; personal property, \$1500. What are the taxes at the rate of .9%?

### Process and Explanation

$\$6000 + \$1500 = \$7500$ , or total assessed valuation.

.9% of \$7500 =  $.009 \times \$7500 = \$67.50$ , the taxes. *Ans.*

### Oral Exercise

2. A tax of 5 mills on the dollar is how much on \$100?

3. A tax of  $1\frac{1}{2}\%$  is how much on \$1000?

4. At \$1.60 a hundred what is the tax on \$7500?

5. The assessed valuation of a property is \$3500, rate 1.25%. What are the taxes?

6. The taxes on a farm are \$75; the assessed valuation \$6000. What is the rate?

7. The taxes on a property are \$35, rate \$1.75 per hundred. What is the assessed valuation?

**Written Problems**

169. 1. What is the tax on a house and lot valued at \$2000 if it is taxed at  $\frac{5}{6}$  of its value at \$1.50 per \$100?

2. A quarter section of land, valued at \$85 per acre, is taxed at  $\frac{3}{4}$  of its value at the rate of 70¢ per \$100. What is the total amount of the taxes?

3. A city house and lot with an assessed valuation of \$3500 is taxed  $2\frac{1}{2}\%$ . What is the amount of the tax?

4. The property in a village is valued at \$650,000 and the amount of revenue to be raised is \$5200. What is the tax on property assessed at \$7250?

5. A farmer has 160 acres of land assessed at \$35 per acre, with buildings valued at \$2800. He has personal property amounting to \$2400, of which \$700 is exempt by law. Find his total tax at  $9\frac{1}{2}$  mills.

6. In a certain township the value of the personal property is \$7500 and that of the real estate is \$1,860,000. The former is taxed at  $\frac{3}{4}$  of its value, and the latter at  $\frac{2}{3}$  of its value. Find the amount of the taxes, the rate being 26.7 mills.

7. A farmer living in a certain county owns 120 acres of land worth \$80 per acre, live stock worth \$1400, and other personal property amount-

ing to \$1750. The personal property is taxed at  $\frac{4}{5}$  of its value and the real estate at  $\frac{3}{4}$  of its value. What is the general tax?

(The general tax levy for this county, in addition to the township and school district levies, is apportioned as follows: state, 1.20 mills; county, 1.53 mills; interest on bonds, .77 mills; road, .50 mills.)

8. His township levy for general and road purposes is .75 and .175 mills, respectively. What is his entire township tax?

9. His school district levy is 2.30 mills. Find the school tax and his entire tax.

10. A city in the above county has a local tax of 7 mills and a school tax of 6 mills. One of its citizens owns property having an assessed valuation of \$12,500, has an income of \$6000, on which he pays an income tax of 1% on all over \$4000, and pays a poll tax of \$3. Find the amount of his local tax, school tax, and of his entire tax.

11. The rate of taxation is 9 mills on the dollar. What is the value per acre of a 320 acre farm upon which the tax is \$163.20 if it is assessed for  $\frac{5}{6}$  its value?

12. In some states tax collectors get a commission of  $2\frac{1}{2}\%$  for collecting. If the net amount of a tax collection for a township was \$7824.80, what amount was collected and what was the commission?

## INSURANCE

### Study Exercise

**170. Insurance** is a contract for protection against loss. There are two principal kinds of insurance, **property insurance** and **life insurance**. **Property insurance** usually protects against loss by fire or water, and, in the case of live stock, against loss by death.

The written contract between the insurance company and the insured is the **policy**. The amount to be paid for the protection is called the **premium**. The **rate of insurance** is usually stated as so many per cent, or so much per \$ 100.

The **amount of premium** in life insurance depends upon the age of the person insured and the kind of policy. A partial list of the rates for the three most common policies for a certain company is given in the following table :

AGE	ORDINARY LIFE	20-PAYMENT LIFE	20-YEAR ENDOWMENT
21	\$ 18.50	\$ 28.30	\$ 47.70
25	20.26	30.17	48.10
28	21.73	31.76	48.47
30	22.90	32.92	48.78
35	26.48	36.27	49.80
40	31.12	40.43	51.83

The principles of percentage apply in insurance.

The face of the policy is the base.

The rate of premium is the rate.

The premium is the percentage.

### Written Exercise

**171.** 1. A house is insured for \$3500 at the rate of 35¢ a hundred per year. What is the annual premium?

#### Process and Explanation

$\$3500 = 35$  hundred dollars.

$35 \times \$ .35 = \$ 12.25$ , the premium. *Ans.*

2. If a house is insured for \$6000 at 35¢ a hundred, what is the premium?

3. The premium for three years is twice that for one year. What is the average annual premium for the house in Problem 2?

4. The premium for five years is three times that for one year. What is the average annual premium for the house in Problem 2?

5. What would be the premium on a \$3500 policy at the rate of  $\frac{1}{3}\%$  per year?

6. What is the premium on a policy of \$3000 taken at the age of 30 for the ordinary life? 20-payment life? 20-year endowment?

7. If a \$5000, 20-payment life policy is taken out at 21 years of age, what is the total amount paid by the policy holder?



**Written Problems**

**172.** 1. If a house is insured for \$1500 for 3 years at 70¢ per \$100, what is the premium?

2. The insurance rate for a house valued at \$4200, having fire protection, is 35¢ per \$100 for one year, twice that amount for three years, and three times that amount for 5 years. What will be the premium for one year if the house is insured for  $\frac{3}{4}$  its value? For three years? For five years?

3. A house cost \$9000 and was insured for  $\frac{2}{3}$  of its value at \$1.25 per hundred for 5 years. What was the premium?

4. Buildings insured against fire for \$3500 at the rate of 60¢ per \$100 are damaged to the extent of \$4850. What is the entire loss to the owner?

5. A farmer pays a premium of \$58.75 for insuring his oats for  $\frac{3}{4}$  of their value at  $1\frac{1}{4}\%$ . What is the value of the oats?

6. A merchant pays a premium of 85¢ per \$100 on his stock, valued at \$34,500 and insured at  $\frac{3}{4}$  of its value. If the goods are entirely destroyed by fire, what is his real loss?

7. A grain dealer bought 6000 bushels of wheat and had it insured for 75% of its cost at 3%. His premium was \$121.50. At what price per bushel must he sell it in order to gain 6% on the total cost?

8. Find the premium at the age of 35 for a \$ 3500 ordinary life policy ; 20-payment life.

9. How much will a man have paid in on a 20-year endowment policy if taken out at the age of 21, the face of the policy being \$2500 ?

10. If a man takes out a \$ 3500 policy in one company at \$24.60 per thousand, and a \$4500 policy in another company at \$25.50 per thousand, find the premiums.

11. If a man pays \$67.50 annually on a \$3000 policy, what is the rate ?

12. A man takes out an \$8000 ordinary life policy, paying an annual premium of \$24.50 per thousand. He dies just before the 15th payment is due. How much will his estate receive above what he paid the company ?

13. A cargo of coffee costing \$ 28,000 is insured at the rate of  $1\frac{3}{4}\%$  for the amount which will cover the cost of the coffee and the premium. Find the face of the policy.

14. A grain dealer in Chicago ordered his agent at Duluth to buy 5000 bushels of wheat at 65 ¢, 4500 bushels at 50 ¢, 6500 bushels at 55 ¢, paying  $2\frac{1}{4}\%$  commission for buying. The grain was shipped down the lakes, and a policy at  $1\frac{1}{2}\%$  was taken out to cover the cost of the grain and commission. Find the amount of the policy and the premium.

## INTEREST

**173. Interest**, as the term is commonly employed, is the sum paid for the use of money. It is usually reckoned by taking a certain per cent of the amount loaned for the period of one year.

The **principal** is the sum loaned. The **rate of interest** is the per cent of the principal paid for one year. The **amount** is the sum of the principal and interest. The **legal rate** is the rate established by law; and it can be collected when no rate is specified in the contract. The legal rate varies in different states.

**Usury** is interest charged in excess of that allowed by law. Various penalties for taking usury are prescribed in most of the states. **Simple interest** is interest on the principal only.

In interest a new factor, *time*, is introduced into the problem.

The relation that exists between the various factors in interest may be shown in formulas as follows:

Interest = principal  $\times$  rate  $\times$  time (in years).

$$I = prt.$$

Principal = interest  $\div$  (rate  $\times$  time).

$$P = \frac{i}{rt}$$

Time = interest  $\div$  (principal  $\times$  rate).

$$T = \frac{i}{pr}$$

Rate = interest  $\div$  (principal  $\times$  time).

$$R = \frac{i}{pt}$$

Amount = principal + interest.

$$A = p + prt.$$

### SIMPLE INTEREST METHOD

**174.** Interest is computed in various ways. Usually, for periods less than one year, interest is reckoned on the basis of 30 days to the month and 12 months to the year, or 360 days to the year.

1. Find the interest on \$625.50 at 5 % for 4 years, 7 months, and 20 days.

#### Process

Interest for 1 year is \$625.50 $\times$ .05 . . . .	\$ 31.275
Interest for 4 years is \$31.275 $\times$ 4 . . . .	125.10
Interest for 7 months is $\frac{7}{12}$ of \$31.275 . . . .	18.24
Interest for 20 days is $\frac{2}{3}$ of $\frac{1}{12}$ , or $\frac{1}{18}$ , of \$31.275	1.74
Total . . . . .	\$ 145.08 <i>Ans.</i>

What formula applies in the exercise ?

Explain how it applies.

**Written Exercise**

**175.** Find the interest on :

1. \$1500 for 2 years 4 months 10 days at 8 %.
2. \$635 for 1 year 3 months 2 days at 7 %.
3. \$955 for 3 years 6 months 15 days at 6 %.
4. \$2500 from April 1, 1911, to July 1, 1914,  
at 8 %.
5. \$1450 from March 5, 1910, to August 10,  
1913, at 5 %.
6. \$350.75 from February 10, 1911, to January  
1, 1915, at  $5\frac{1}{2}$  %.

Find the interest and the amount :

7. \$670 for 3 years 5 months 17 days at 4 %.
8. \$3000 from Sept. 10, 1910, to Jan. 1, 1914,  
at 6 %.
9. \$1850 from May 20, 1908, to Oct. 10, 1911,  
at  $5\frac{1}{2}$  %.
10. \$1725 from Nov. 5, 1907, to Mar. 1, 1910,  
at 10 %.

**Six Per Cent Method**

**176.** The plan of this method is to find the interest on \$ 1 at 6 % for the given time and then to multiply this sum by the principal. The following values are of practical use :

The interest on \$ 1 for 1 yr. at 6 % is \$.06.

The interest on \$ 1 for 1 mo. at 6 % is \$.005.

The interest on \$ 1 for 1 da. at 6 % is \$.000 $\frac{1}{6}$ .

1. Compute the interest at 6 % on \$ 279.60 for 3 years, 9 months, 24 days.

**Process and Explanation**

Interest on \$ 1 for 3 years is  $\$.06 \times 3$  . . . \$.18

Interest on \$ 1 for 9 months is  $\$.005 \times 9$  . . . .045

Interest on \$ 1 for 24 days is  $\$.000\frac{1}{4} \times 24$  . . . .004

Interest on \$ 1 for 3 years, 9 months, 24 days \$ .229

Hence the interest on \$ 279.60 for 3 years, 9 months, 24 days is  $\$ 279.60 \times \$.229 = \$ 64.03$ . *Ans.*

What formula applies here? Explain how it applies.

The six per cent method may be used for finding the interest at other rates by taking the fractional part the required rate is of 6 % as a multiplier of the result obtained by the method.

**Written Exercise**

**177.** Find the interest by the six per cent method:

1. \$ 395 for 1 year 11 months 12 days at 6 %.
2. \$ 914.50 for 3 years 6 months 18 days at 6 %.
3. \$ 732.25 from Jan. 3, 1910, to Oct. 20, 1913, at 6 %.
4. \$ 1017.95 for 4 years 7 months 14 days at 6 %.
5. \$ 2180.60 from Mar. 4, 1907, to Feb. 6, 1913, at 6 %.

6. \$ 540 from July 9, 1914, to Feb. 17, 1915, at 6 %.

7. \$ 350 for 1 year 7 months 15 days at 2 %.

8. \$ 715 for 2 years 2 months 28 days at  $4\frac{1}{2}$  %.

9. \$ 1576 from Dec. 13, 1906, to April 10, 1909, at 5 %.

10. \$ 2935 from Nov. 4, 1910, to Aug. 1, 1914, at 7 % ?

11. \$ 1640.35 from Oct. 25, 1911, to May 18, 1914, at 8 %.

12. \$ 347 for 2 years 8 months 27 days at  $5\frac{1}{2}$  %.

13. \$ 1175 from Sept. 30, 1904, to April 12, 1907, at 4 %.

#### Written Problems

**178.** 1. A note given October 5, 1913, for \$ 654 at 7 % was paid December 23, 1915. What amount of money was required to cancel the note ?

2. A bill of goods amounting to \$ 5675 is sold on 30 days' time or at a discount of 5 % for cash. Which is better for the buyer to accept if money is worth 8 % ?

3. A five-room cottage can be bought for \$ 2500 or rented for \$ 25 a month. Which is better, to buy or rent, if money is worth 7 % and the taxes, insurance, and up-keep cost \$ 65 a year ?

4. What principal at 6 % will produce \$ 112 interest in 1 yr. 5 mo. ?

5. Find the principal which will amount to \$ 862.50 in 2 yr. 4 mo. at 6 %.
6. At what rate will \$480 yield \$ 66.13 in 3 yr. 5 mo. 10 da. ?
7. In what time will \$ 490.92 yield \$ 49.75 at 8 % ?
8. A bank pays  $3\frac{1}{2}$  % interest on a deposit of \$ 8000. The bank loans \$ 5000 for 3 months at 6 % ; all of it for 4 months at  $5\frac{1}{2}$  % ; and again \$ 6000 for 5 months at 5 % . Does the bank gain or lose and how much ?

### Exact Interest Method

**179.** The United States government and some banks and business institutions use the **exact interest method** of computing interest. For finding the exact time between two dates a convenient table is often used in banks and business offices.

This method takes account of the exact number of days in the time interval and proceeds upon the basis of 365 days to the year. Thus: 2 years 122 days gives  $2\frac{122}{365}$  as the time multiplier.

Exact interest may also be obtained from simple interest. Thus: by simple interest 1 day's interest is  $\frac{1}{360}$  of a year's interest, and by exact interest 1 day's interest is  $\frac{1}{365}$  of the interest for a year. The difference between  $\frac{1}{360}$  and  $\frac{1}{365}$  is  $\frac{1}{73}$ . That is, the exact interest is  $\frac{1}{73}$  less than the simple interest.



**Process and Explanation**

1. What is the exact interest on \$ 632.96 for 240 days at 6 % ?

(a) Interest for one year is  $\$ 632.96 \times .06 = \$ 37.98$ .

Interest for  $\frac{240}{360}$  of a year is  $\frac{240}{360} \times \$ 37.98 = \$ 24.97$ .

(b) 240 days is  $\frac{240}{360}$  or  $\frac{2}{3}$  of a year. Hence the simple interest for 240 days is  $\frac{2}{3}$  of  $\$ 37.98 = \$ 25.32$ .

$\frac{1}{3}$  of  $\$ 25.32 = \$ .35$ .

$\$ 25.32 - \$ .35 = \$ 24.97$ , the exact interest. *Ans.*

**Written Exercise**

**180.** Find the exact interest :

1. \$ 860 for 1 year 4 months 17 days at 7 %.
2. \$ 1345 for 2 years 9 months 23 days at 6 %.
3. \$ 2631.50 from Mar. 19, 1914, to Sept. 3, 1915, at  $5\frac{1}{2}$  %.
4. \$ 1930 from Oct. 6, 1909, to June 10, 1914, at 8 %.
5. \$ 640.80 from March 15, 1915, to June 24, 1915, at 6 %.
6. \$ 1254.25 from June 24, 1915, to Sept. 18, 1915, at 7 %.
7. \$ 4872.80 from May 17, 1915, to Dec. 27, 1916, at 8 %.
8. \$ 2958 from Sept. 28, 1915, to Jan. 6, 1916, at  $6\frac{1}{2}$  %.

**Written Problems**

**181.** 1. What is the difference between simple and exact interest on \$ 7650 for 154 days at 6 %?

2. A banker borrowed \$ 15,000 in Illinois at 5 % exact interest, and loaned it in Nebraska at 8 % simple interest. What was his profit in 185 days?

3. A man bought a farm for \$ 8000. He paid \$ 1600 cash and \$ 800 a year thereafter until it was paid for. With money worth 6 % what was the total amount paid for the farm? Get the interest by both methods and find the difference between them.

4. A farmer bought a horse for \$ 250. He paid \$ 60 cash. Which is the better proposition for him, to borrow the rest at the bank at 6 % exact interest, or give his note at simple interest at  $5\frac{1}{2}$  % for 240 days?

5. A note for \$ 1250 dated July 28, 1914, at 8 % had the following indorsements: August 8, 1914, \$ 50; December 5, 1914, \$ 50; January 9, 1915, \$ 50; February 3, 1915, \$ 50; April 5, 1915, \$ 50. If the interest stopped on the amount paid at the time of each payment, what was due July 28, 1915?

### COMPOUND INTEREST

**182.** If when the interest falls due it is added to the principal and the amount forms a new principal which draws interest, the interest is said to be compounded and is called **compound interest**.

The interest may be compounded quarterly, semi-annually, or annually. Compound interest is allowed on deposits in savings banks. It is also used by business men in finding the cumulative value of investments at a given rate, where the earnings are not withdrawn.

1. Find the compound interest and amount on \$200 for 3 years at 7%, interest compounded annually.

**Process and Explanation**

\$200 is the first principal.

$\$200 \times .07 = \$14$ , first interest.

$\$200 + \$14 = \$214$ , the second principal.

$\$214 \times .07 = \$14.98$ , second interest.

$\$214 + \$14.98 = \$228.98$ , third principal.

$\$228.98 \times .07 = \$16.0286$ , third interest.

$\$228.98 + \$16.03 = \$245.01$ , amount at the end of the third year.

Hence,  $\$245.01 - \$200 = \$45.01$ , compound interest for 3 years. *Ans.*

**Written Exercise**

**183.** Find the compound interest on :

1. \$265 for 3 years at 4%.
2. \$2400 for 4 years at 6%.
3. \$3650 for 3 years at 5%.
4. \$1925 for 5 years at 8%.
5. \$4270 for 4 years at 7%.

Find the amount and interest compounded semi-annually :

6. \$300 for 1 year 6 months at 5%.

7. \$ 1250 for 1 year 9 months at 6 %.
8. \$ 4950 for 3 years at 5 %.
9. \$ 6200 from July 1, 1909, to Nov. 25, 1912, at 4 %.

### Written Problems

**184.** 1. A boy on his ninth birthday has \$ 300 deposited for him in a savings bank. If the bank pays 4 % interest compounded semiannually, what amount will he have to his credit when he is 21 years of age?

2. A man deposited \$ 1750 in a savings bank, which pays 4 % semiannually, for 3 years. Compare the amount with that resulting from a simple interest loan of the same principal for the same time at 5 %.

3. A father on his son's twelfth birthday deposited \$ 15. If he deposits \$ 15 every six months thereafter until the son is 21, how much will he have to his credit if the bank pays 4 %, compounded semiannually?

4. What sum deposited at 4 % interest, compounded annually, will amount to \$ 1000 in 30 years?

5. A man deposited \$ 1375 in a savings bank, which pays 3 % interest compounded semiannually, for five years. Compare the amount with that resulting from a simple interest loan of the same principal for the same time at  $4\frac{1}{2}$  %.

## BUSINESS PAPERS

### NOTES

**185.** A note is a written promise to pay a certain sum of money at a specified time. The following is the usual form of a note:

<i>\$75.00</i>	<i>Manhattan, Kansas, Jan. 30, 1915.</i>
<i>One year after date---I---promise to pay to</i>	
<i>-----Clark Stanley,-----or order,</i>	
<i>Seventy-five-----Dollars.</i>	
<i>Value Received, with interest at 6%.</i>	
<i>Dudley Stanton.</i>	

The payment of a note is often made more secure by the signatures of other persons, known as **indorsers**, or by a conveyance of property, real or personal, in case the note is not paid. When property is designated as security, the instrument of conveyance is called a **mortgage**. Mortgages are of two kinds: **chattel**, or a mortgage on personal property, and a **real estate mortgage deed**. In either case the owner retains possession of the property until, upon non-payment of the note, legal proceedings known as **foreclosure** require that the property be turned over to satisfy the claim.

The indorsement may appear on the back of the note as follows :

In the first two of these indorsements Clark Stanley guarantees the payment of the note. If Clark Stanley does not wish to become responsible for the payment of the note in case Dudley Stanton fails to pay it when due, he may indorse the note *without recourse* as indicated in the third indorsement.

*Clark Stanley.*

INDORSEMENT IN BLANK.

*Pay to the order of  
The Manhattan Bank.*

*Clark Stanley*

INDORSEMENT IN FULL.

*Without recourse.*

*Clark Stanley.*

## CHECKS

**186.** Money on deposit in a bank in an *open account* is subject to check; *i.e.*, the bank will pay any part or all of it upon a written order from the depositor, called a **check**. The check is usually in the following form :

*No. 00*

*Manhattan, Kansas, Jan. 30, 1916*

**The Manhattan Bank**

Manhattan, Kansas

*Pay to* ..... *Clark Stanley* ..... *or order*

*Seventy-nine and  $\frac{50}{100}$  ..... Dollars.*

*\$ 79  $\frac{50}{100}$*

*Dudley Stanton.*

A check is usually made payable to a person or to his order. When the check has been paid it is finally returned to the maker, or the depositor, who signed the check. A depositor wishing to withdraw money makes the check payable to "self." If a depositor wishes to send money away to a stranger, it is desirable to have the check show that it has actual value. To do this the maker takes it to the bank upon which it is drawn and has the cashier write across the face and over his signature the words "good when properly indorsed." This makes what is called a **certified check**. The bank simply sets aside enough from the depositor's account to pay the check and will

not release that amount until the check has been returned.

*Clark Stanton.*

INDORSEMENT IN BLANK.

*For deposit with  
The Manhattan Bank.*

*Clark Stanton.*

INDORSEMENT FOR DEPOSIT.

*Pay to John Field.*

*Clark Stanton.*

INDORSEMENT IN FULL.

When one wishes to cash a check he writes his name on the back, or in other words he **indorses** the check, and presents it for payment. When one wishes to sell a check that has been made payable to him, he

may do so by indorsing it; and the person to whom he has sold it will then be able to collect the face of the note by indorsing it and then presenting it

to the bank for payment. The indorsement on the check will appear as on the opposite page.

Money may be deposited in a *closed account*, — one that is not subject to check. In such cases, the bank may issue a **certificate of deposit**, which certifies the amount that will be paid to the depositor when the certificate is returned properly indorsed. This may be a **demand** or a **time certificate**. Time certificates usually draw interest.

#### Written Exercise

**187.** 1. Write a note for \$ 350 payable to some member of the class for 90 days at 6 %. Determine the interest and amount.

2. A note was given at Topeka, Kansas, January 29, 1915, by A. G. Hunting to H. R. Sunderland for \$ 128.50, to run 60 days at 7 %. Write the note up in the proper form indicating that P. T. Small was a security for its payment. Determine the interest and amount of the note.

3. Mr. C. F. Garland, Peoria, Illinois, borrowed \$212.50, February 16, 1916, at 6 % for 1 year from J. H. Chamberlain. Make out the note in the proper form indicating that B. R. Carter was a security for its payment. Find the interest and amount due at the end of the year.

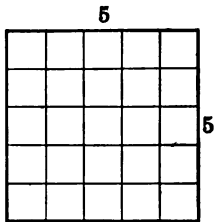
4. Secure blank checks, and have the pupils write checks to each other until they are familiar with the proper forms.



## POWERS AND ROOTS

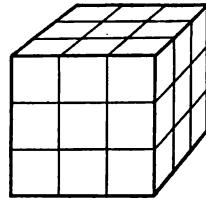
### POWERS

**188.** The square in the accompanying figure evidently has 5 units on each side and an area of 25



square units. Hence, 25 is called the square of 5. In general we have the definition: The **square of a number** is the product of the number taken twice as a factor.

The cube in the figure here has 3 units on each edge and a volume of 27 cubic units. Hence, 27 is called the cube of 3. The **cube of a number** is the product of the number taken 3 times as a factor.



Squares and cubes are special cases of powers of numbers. Taking a number two times as a factor gives the second power; three times as a factor the third power; four times as a factor the fourth power, etc.

Instead of writing at length  $4 \times 4 \times 4 \times 4 \times 4$  we may use the simpler form of  $4^5$ . Hence 4 is called the base and 5 the exponent. The exponent of a

power is a number placed to the right and above the base to indicate how many times the base is taken as a factor.

### Written Exercise

**189.** Find the value of:

- |            |                      |                       |             |
|------------|----------------------|-----------------------|-------------|
| 1. $28^2$  | 4. $1.5^3$           | 7. $6^4$              | 10. $426^2$ |
| 2. $11^3$  | 5. $(\frac{5}{6})^2$ | 8. $2^8$              | 11. $3.7^3$ |
| 3. $116^2$ | 6. $(\frac{5}{9})^3$ | 9. $(1\frac{2}{3})^5$ | 12. $.9^4$  |

Often the square of a number can be found more readily by use of a formula than by the regular method of multiplication. The truth of the following rule is illustrated by the adjoining figure.

The illustration shows the square of 43;  $43^2 = (40 + 3)^2 = 40^2 + 2 \times 40 \times 3 + 3^2 = 1600 + 240 + 9 = 1849$ . The method here given can be used with any two numbers.

$40 \times 3$	$3^2$
$40^2$	$40 \times 3$
40	3

Representing any two numbers by the lines  $m$  and  $n$ , we see that the square of their sum involves two squares  $m$  and  $n$ , and two rectangles  $mn$ . Hence, the following **rule**: The square of the sum of two numbers equals the square of the first plus twice the product of the first and second, plus the square of the second. Or in letters, the formula:

**Formula:**  $(m + n)^2 = m^2 + 2mn + n^2$ .

**Written Exercise**

**190.** Use the formula to find the squares.

- |       |       |         |         |         |
|-------|-------|---------|---------|---------|
| 1. 41 | 5. 93 | 9. 105  | 13. 327 | 17. 253 |
| 2. 27 | 6. 86 | 10. 91  | 14. 214 | 18. 79  |
| 3. 35 | 7. 82 | 11. 59  | 15. 47  | 19. 416 |
| 4. 68 | 8. 75 | 12. 123 | 16. 96  | 20. 425 |

**Written Problems**

**191. 1.** A fence surrounding a square field has an entire length of 320 rods. How many acres in the field?

2. A square court is to be paved with Belgian blocks, each block being an eight-inch cube. If the court is 8 rods square, how many blocks will be required?

3. A cubical tank is 10 feet 8 inches on a side, inside measurements. How many gallons will it hold?

4. What will it cost to line an open tank which is 12 feet 4 inches long, 4 feet 5 inches wide, and 3 feet deep, at  $9\frac{1}{2}$ ¢ a square foot?

5. The pedestal of a monument is a cube of granite 3 feet 4 inches on a side. What is its volume?

6. The length of a side of the square base of the great Pyramid of Cheops is approximately 45 rods 10 feet. How many acres does the base cover?

## ROOTS

**192.** If 36 be written as the product of two equal factors 6 and 6, that is,  $36 = 6 \times 6$ , then one of these factors is called the square root of 36. The **square root** of a number is one of the two equal factors of the number. Similarly, if we write 125 as  $5 \times 5 \times 5$ , then one of these factors is called the cube root of 125. The **cube root** of a number is one of the three equal factors of the number.

The sign  $\sqrt{\phantom{x}}$ , called the **radical sign**, is used to indicate the root of a number. To show what root is to be taken, a figure called the index of the root is placed in the opening of the radical sign. Thus  $\sqrt[3]{27}$  indicates the cube root of 27. When no index is written, the square root is meant.

Since  $1^2 = 1$ ,  $10^2 = 100$ ,  $100^2 = 10,000$ , etc., where do the square roots of all the numbers between 1 and 100 lie? between 100 and 10,000?

If a whole number be divided into groups of two figures each from the right to the left, the number of groups will equal the number of figures in the root.

Since raising to the second power and extracting the square root are opposite processes, compare the process of extracting the square root with the process of squaring a number.

1. Extract the square root of 1849.

Process	Explanation :
1849 (40 + 3	on separating the number into periods
1600	show that the root contains 2 figures.
83 $\overline{)249}$	The first group of figures, "18", con-
249	tains the square of the tens number of
	the root. The greatest square in 18 is

16; and the square root of 16 is 4 (40 units). Four is therefore the tens figure in the root. Subtracting the square of the tens from 1849, we have the remainder 249. This must contain two times the tens, times the units plus the units squared. Twice the 4 tens is 8 tens. Eight is contained in 24 tens 3 times. We therefore try 3 as the next figure of the root. Now the remainder may be written in the form (twice the tens plus the units) times the units. Hence, the quantity in the parenthesis is to be used as the divisor in the final determination of the unit figure of the root. Therefore, in the example we have (80 plus 3) times 3, which gives 249. Hence, 43 is the required square root of 1849.

In practice the work is shortened by the omission of unnecessary zeros as follows :

$$\begin{array}{r}
 1849 \text{ (43} \\
 16 \\
 83 \overline{)249} \\
 \underline{249}
 \end{array}$$

**Rule for the extraction of square root :** *Begin at the decimal point and separate the number into groups of two figures each, to the left for the integral part and to the right for the decimal part of the number.*

*Find the greatest square in the left period, and write down its square root as the first figure in the required result.*

*Subtract the square of this root figure from the first period, and bring down the next period. Double the part of the root already found (regarded as tens) for a trial divisor, divide it into the remainder, and write the integral part of the quotient as the next figure of the root.*

*Add to the trial divisor the root figure just found to make the complete divisor, multiply this result by the last root figure, and subtract the product from the last remainder.*

*Bring down the next period, and proceed as before until the desired number of figures of the root have been found.*

#### Written Exercise

**193.** Extract the square root of the following:

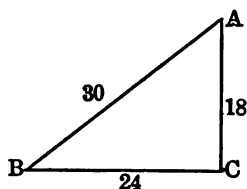
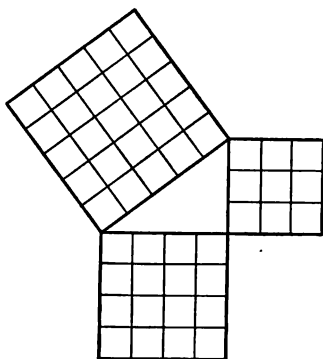
- |                       |                         |                                |
|-----------------------|-------------------------|--------------------------------|
| 1. 109,561.           | 7. .0000064.            | 13. 2.3 to 3 places.           |
| 2. 4,198,401.         | 8. 1,027.8436.          | 14. 78.15 to 3 places.         |
| 3. $\frac{64}{361}$ . | 9. .00267289.           | 15. 219 to 4 places.           |
| 4. .7329.             | 10. $\frac{169}{876}$ . | 16. 165 to 4 places.           |
| 5. 18.9225.           | 11. 40,195,600.         | 17. 47 to 4 places.            |
| 6. 366,025.           | 12. 7 to 3 places.      | 18. $\frac{5}{9}$ to 4 places. |
| 19. 381 to 4 places.  | 20. 905 to 4 places.    |                                |

#### The Solution of the Right Triangle

**194.** The square on the hypotenuse of a right triangle equals the sum of the squares on the other two sides.

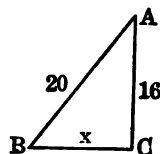
For example: if  $AC = 18$  and  $BC = 24$ , find the length of  $AB$ .  $AB^2 = AC^2 + BC^2$ . Why? Or  $AB^2 = 18^2 + 24^2 = 324 + 576 = 900$ , or  $AB = 30$ .

From the geometric facts stated in the pre-



ceding paragraph, the square on either side of a right triangle equals the difference of what squares?

If  $AB = 20$ , and  $AC = 16$ , find  $BC$ .



### Written Problems

**195. 1.** A square field contains 10 acres. How many rods of fence will it take to inclose it?

**2.** Two sides of a right triangle are 65 and 74 feet. Find to three decimal places the length of the hypotenuse.

**3.** The hypotenuse of a right triangle is 94 feet. One side is 43 feet. Find the length of the other side to three decimal places.

**4.** A rope 314 feet long is stretched from the top of a flagpole 100 feet high. Find the distance

from the base of the pole to the point of contact of the rope with the ground.

5. A pasture in the shape of a right triangle is 120 rods 4 yards and 69 rods 3 yards on the sides about the right angle. Find the length of the hypotenuse.

6. A room is 18 by 14 by 10 feet. How far is it from a floor corner to the diagonally opposite ceiling corner?

7. Find the diagonal of a rectangular field 120 by 80 rods.

8. A baseball diamond is 90 feet on a side. Find the distance from the second base to the home plate.

9. If there are 250 shingles in a bunch, averaging 4 inches in width, how large a square of roof will 8 bunches cover if laid 4 inches to the weather?

10. A cubical box, open at the top, has a surface of 79,380 square inches. Find its dimensions in feet.

11. A cylindrical grain bin 12 feet deep will hold 1500 bushels of wheat. What is its diameter?

12. A tree broken 42 feet from the ground remains fastened to the stump. If the top reaches the ground 54 feet from the stump, what was the height of the tree before it was broken?

13. A 30-foot silo holds 196 tons. What is its diameter if one cubic foot of silage weighs 39.6 pounds?



## RATIO AND PROPORTION

### RATIO

#### Study Exercise

**196.** The ratio of two quantities of the same kind is their relation as expressed by division; thus  $\frac{2}{5}$ ,  $\frac{3}{7}$  are ratios. Another way of writing such ratios is the following:  $2:5$ ;  $3:7$ , which are read 2 is to 5, 3 is to 7. Hence, the ratio relation between two numbers, written in either form, is an indicated division.

The two elements of a ratio are called its **terms**. The **antecedent** is the first term, and the **consequent** is the second. The ratio itself is always an abstract number. Since a ratio is really a fraction, all the rules concerning the operations of fractions will hold here. In particular we note that multiplying or dividing both terms of a ratio by the same number does not change its value.

Often in a statement that contains two or more numbers, a clearer idea of their relation can be had by taking some one of the numbers as a unit of comparison. Thus:  $4:24$  is the same as  $1:6$ . Similarly, by using a series of ratio signs we may compare a set of numbers like 6, 18, 36 by use of

the form  $1:3:6$ . The principle involved is that of dividing the terms of the ratio by the same number without a change of value.

### Oral Exercise

- 197.** 1. Find the number whose ratio to 3 is 4.  
2. Find the number whose ratio to 8 is 5.  
3. What is the number to which 30 has the ratio 5?  
4. What is the number to which 42 has the ratio 6?  
5. The ratio of the height of a tree to that of a post is  $7\frac{1}{2}$ . The post is 6 feet high. How high is the tree?  
6. The ratio of the length of a crib to its width is  $3\frac{1}{2}$ . If the crib is 35 feet long, how wide is it?  
7. Separate 15 into the ratio of 2 to 1.  
8. Separate 20 into the ratio of 3 to 2.  
9. Counting the school days in a week and 4 weeks in a month, what is the ratio of the number of school days to the average number of days in a month?

### Written Exercise

**198.** Reduce each of the following to a ratio having one for its first term :

- |              |              |               |
|--------------|--------------|---------------|
| 1. $7:14$ .  | 3. $17:68$ . | 5. $60:320$ . |
| 2. $11:33$ . | 4. $14:30$ . | 6. $9:108$ .  |

7. 28 ft. : 142 ft.    9. .1 oz. :  $\frac{5}{8}$  oz.    11. .512 : 8.  
8. 19 lb. : 65 lb.    10.  $\frac{5}{8}$  : 40.    12. .78 ft. : 17 in.

Express the following sets of numbers by a series of ratios having one for the first term :

13. 9 : 27 : 72.                      15. 5 : 19 : 26.  
14. 7 : 98 : 84.                      16.  $\frac{2}{3}$  :  $\frac{3}{4}$  : 11.

### Written Problems

**199.** 1. In an experiment in alfalfa breeding 6.3 % of the plants of the American and 39.3 % of those of the Turkestan variety withstood a hard frost without injury. Determine the comparative frost-resisting powers of the two varieties in the form of a ratio having one for the first term.

2. The sunshine record in the neighborhood of St. Paul, Minn., for 1911 shows the presence of sunshiny days for  $\frac{3}{5}$  of the time during the spring and summer months, and for  $\frac{1}{2}$  of the time during the fall and winter months. Find the ratio of the sunshiny days to the cloudy days during the year.

3. In 1910 the enrollment of students in the colleges of agriculture and mechanic arts of the United States in residence courses, was 45,000 ; in correspondence courses, 30,000 ; and in extension courses, 21,000. Compare these numbers in the form of a ratio, taking the number in the extension courses as one.

4. In 1912 the values of the four principal crops of the United States in millions of dollars were as follows: corn, 1759; hay, 861; cotton, 735; wheat, 596. Compare these values in the form of a ratio, using the value of wheat as the basis of comparison.

5. In a germination experiment with wheat in 1909, 97% of the kernels of greater density germinated, and 71% of the kernels of lesser density germinated. Express these results in ratio form.

6. According to the census of 1907, the population per square mile on the great continents is as follows: Europe, 106; Asia, 58; Africa, 11; America, 9. Write these results in the form of a ratio series, with the population of America as the unit of comparison.

7. The average yield of wheat in bushels per acre of the chief wheat-producing nations of the world in 1912 was: United States, 15.9; Russia, 10.2; Germany, 33.7; Austria, 22.4; France, 20.4; Great Britain, 31.7. Determine the comparative yield per acre of these countries, taking the United States yield as unity.

## PRACTICAL APPLICATIONS

### (1) SPECIFIC GRAVITY

**200.** The specific gravity of a substance is the ratio of its weight to the weight of an equal volume

of water. It is known that one cubic foot of pure water weighs nearly 62.5 pounds. Hence, the specific gravity of any substance may be found directly when its weight per cubic foot is known, or the weight per cubic foot can be found when the specific gravity is given.

### Written Exercise

**201.** Find the specific gravity of the following substances whose weight per cubic foot is given :

- |                              |                          |
|------------------------------|--------------------------|
| 1. Cast iron, 450 pounds.    | 5. Ice, 57.5 pounds.     |
| 2. Wrought iron, 480 pounds. | 6. Cork, 15 pounds.      |
| 3. Steel, 490 pounds.        | 7. Butter, 58.7 pounds.  |
| 4. Copper, 552 pounds.       | 8. Marble, 168.7 pounds. |

Find the weight per cubic foot of the following substances whose specific gravities are given :

- |                           |                       |
|---------------------------|-----------------------|
| 9. Lead, 11.418.          | 19. Poplar, .48.      |
| 10. Silver, 10.5.         | 20. White oak, .77.   |
| 11. Gold, 19.5.           | 21. Milk, 1.03.       |
| 12. Tin, 7.291.           | 22. Alcohol, .79.     |
| 13. Mercury, 13.596.      | 23. Linseed oil, .94. |
| 14. Brick, common, 1.79.  | 24. Turpentine, .99.  |
| 15. Brick, pressed, 2.16. | 25. Sulphur, 2.04.    |
| 16. Hickory, .77.         | 26. Lime, .804.       |
| 17. White pine, .45.      | 27. Salt, 2.13.       |
| 18. Yellow pine, .61.     |                       |

### Written Problems

**202.** 1. How many tons of ice may be harvested from a section of a pond 128 feet by 320 feet if the ice is  $8\frac{1}{2}$  inches deep ?

2. Find the weight of a cubic meter of lead, in pounds; in kilograms.
3. How high must a column of mercury be to cause a pressure 16.4 pounds per square inch?
4. If 50 cubic inches of a substance weigh 8 pounds, what is its specific gravity?
5. Find the weight of a marble shaft 8 feet high and having a uniform cross section of 2 feet by 2 feet 6 inches.

## (2) RATIONS

**203.** A matter of importance to every farmer in handling his stock is that of feeding. The question of how to make feeds yield the most in animal products is ever before him. The problem is a complex one, and the exact solution of it is not known. Much has been done, however, in ascertaining the combination of feeds best adapted for a given purpose with different animals under given conditions. The results of experiments along this line have been embodied in a table of feeding standards which may well be used as a practical guide to feeders.

A **ration** is the amount of feed given to an animal during 24 hours.

A **balanced ration** is one which contains the various nutritive elements in such amounts as best to serve the purpose for which the animal is being fed.

Since the value of a given feed depends for production purposes upon the amounts of digestible nutrients it contains, a convenient table giving such information with respect to the common feeds used for farm animals is inserted here.

TABLE OF DIGESTIBLE NUTRIENTS IN CERTAIN FEEDS

FEEDS	PER CENT OF PROTEIN	PER CENT OF CARBOHYDRATES	PER CENT OF FATS
Corn . . . . .	7.14	66.12	4.97
Kafir . . . . .	5.78	53.58	1.33
Corn stover . . . .	1.98	33.16	0.57
Corn silage . . . .	1.21	14.56	0.88
Corn meal . . . . .	6.26	65.26	3.5
Corn-and-cob meal .	4.76	60.06	2.94
Oats . . . . .	9.25	48.34	4.18
Wheat bran . . . .	12.01	41.23	2.87
Wheat middlings . .	12.79	53.15	3.4
Cottonseed meal . .	37.01	16.52	12.58
Timothy hay . . . .	2.89	43.72	1.43
Alfalfa hay . . . .	13.24	39.26	0.89
Red clover hay . . .	7.38	38.15	1.81
Prairie hay . . . .	0.61	46.9	1.97
Cowpea hay . . . .	10.79	38.4	1.51
Soybean hay . . . .	10.78	38.72	1.54
Whole milk . . . . .	3.38	4.8	3.7
Skim milk . . . . .	3.01	5.1	0.3
Linseed meal . . . .	28.76	32.81	7.06
Shorts . . . . .	16.9	62.4	5.1

The following table of feeding standards, showing the amounts of nutrients required per day for 1000 pounds live weight, is the one in largest use. Any such table should be taken as a useful guide

to be modified in accordance with available feeds, market prices, and other conditions :

TABLE OF FEEDING STANDARDS

(Selected from Wolf-Lehman tables)

ANIMAL	DIGESTIBLE NUTRIENTS		
	Protein	Carbohydrates	Fats
Horse (heavy work) . . . . .	2.5	13.3	0.8
Horse (light work) . . . . .	1.5	9.5	0.4
Fattening cattle (first period) .	2.5	15.0	0.5
Fattening cattle (second period)	3.0	14.5	0.7
Fattening cattle (third period) .	2.7	15.0	0.7
Dairy cow (16½ lb. milk daily) .	2.0	11.0	0.4
Dairy cow (22 lb. milk daily) .	2.5	13.0	0.5
Fattening swine (first period) .	4.5	25.0	0.7
Fattening swine (second period)	4.0	24.0	0.5
Fattening swine (third period) .	2.7	18.0	0.4
Fattening sheep (first period) .	3.0	15.0	0.5
Fattening sheep (second period)	3.5	14.5	0.6
Growing cattle (6 to 12 mo. old)	2.5	13.2	0.7
Growing swine (3 to 5 mo. old) .	5.0	23.1	0.8

In comparing a given ration with one meeting the requirements of the feeding standards, use must be made of the per cent table of nutrients in order to determine their amounts in pounds in the ration.

The comparative costs of different rations intended to serve the same purpose, can of course be found if the prices of feeds are known. Pupils should make a local price list of the common feeds for the class use.



**Oral Exercise**

**204.** 1. How many pounds each of the digestible nutrients in 100 pounds of corn? In 500 pounds?

2. What is the total amount of digestible nutrients in 100 pounds of corn? In 500 pounds?

3. How many pounds of each of the digestible nutrients will a 1500-pound horse at light work require?

4. How many pounds of oats would be required for 37 pounds of digestible protein?

5. How many pounds of skim milk will be required to furnish .3 pound of fats?

**Written Problems**

**205.** In a feeding experiment with a large number of work horses at a military post (Fort Riley) the following were some of the rations made use of in the tests calculated per 1000 pounds live weight at light work:

**Ration No. 1.** Oats, 10.51 pounds; prairie hay, 12.25 pounds.

**Ration No. 2.** Corn, 5.16 pounds; bran, 2.58 pounds; linseed meal, .86 pound; and prairie hay, 12.05 pounds.

**Ration No. 3.** Oats, 1.70 pounds; corn, 6.8 pounds; alfalfa hay, 8.5 pounds.

**Ration No. 4.** Oats, 3.39 pounds; corn, 5.09 pounds; bran, 3.39 pounds; timothy hay, 10.17 pounds.

1. Find the cost of each ration and compare the costs, using local prices.

2. Ration No. 5 — oats, 3.36 pounds; corn, 6.72 pounds; prairie hay, 11.75 pounds — was also used in the experiment mentioned above. In what respect does this ration fail to meet the needs of a horse doing light work? Compare with ration No. 3 as to cost.

3. Wherein will an entire corn meal ration of 37.2 pounds fail to meet the needs of a fattening pig during the first feeding period?

4. How will the ration, corn meal, 35.7 pounds, and alfalfa hay, 6.1 pounds, compare with the feeding standard under the conditions of Problem 3? Compare the cost of the ration with the ration in Problem 3.

5. In a station hog-feeding experiment the following ration was found to be one of the most satisfactory for economical purposes for pork production: corn meal, 23.87 pounds; shorts, 8.53 pounds; meat meal, 1.71 pounds. The meat meal used contained 46 % protein and 10 % fat. Compare this ration with the standard requirements for fattening swine during the first period. Also, with corn meal at 95¢ per hundred, shorts at \$1.20 per hundred, and meat meal at \$2.05 per hundred, determine the cost of the ration.

6. A farmer makes use of a ration consisting of shelled corn, 1.23 pounds; clover hay, .78 pound; corn silage, 1.20 pounds, for a lamb. If this is the

amount of feed given daily to a lamb weighing 75 pounds, find how nearly this meets his requirements during the first fattening period. Solve on the supposition that the amount of nutrient requirements varies as the weight of the animal.

7. How nearly will the following ration meet the needs of a 1000-pound two-year-old steer during the second part of the fattening period: shelled corn, 18.47 pounds; clover hay, 2.72 pounds; linseed meal, 9.42 pounds?

8. Is the following ration any nearer the requirement: shelled corn, 22.14 pounds; prairie hay, 6.8 pounds; linseed meal, 2.46 pounds?

9. According to one authority 500 pounds of live weight of hens in full laying require for best results the following daily ration: ash, 1.5 pounds; protein, 5.0 pounds; carbohydrates, 18.75 pounds; fats, 1.75 pounds. Find in terms of per cent the correct amount of each food constituent for a laying hen.

### (3) NUTRITIVE RATIO

**206.** It has been found that the fats in a ration contain about  $2\frac{1}{4}$  times as much energy as an equal weight of carbohydrates or protein. Hence, in a comparison of values of these nutritive elements, the number expressing the amount of fats must be multiplied by  $2\frac{1}{4}$ .

A narrow ration is one in which the amount of protein is relatively greater than that of the standard ration. A wide ration is one in which the amount of protein is relatively less than that of the standard ration.

The nutritive ratio of a ration is the ratio of the weight of the protein to the sum of the weights of the carbohydrates plus  $2\frac{1}{4}$  times the fats. In mathematical formula we have,

### Formula

$$\text{Nutritive ratio} = \frac{\text{Protein}}{\text{Carbohydrates} + (2\frac{1}{4} \times \text{fats})}$$

1. Find the nutritive ratio of the following ration for fattening pigs: 4.5 pounds of protein, 25 pounds of carbohydrates, and .7 pound of fats.

### Solution by Formula

$$\text{Nutritive ratio} = \frac{4.5}{25 + (2\frac{1}{4} \times .7)} = \frac{1}{5.91} = 1:5.91. \text{ Ans.}$$

### Written Exercise

**207.** Find the nutritive ratios of the following rations:

1. For a horse at light work: 1.5 lb. protein, 9.5 lb. carbohydrates, and .4 lb. fats.
2. For a dairy cow: 2.5 lb. protein, 13 lb. carbohydrates, and .5 lb. fats.

3. For growing cattle: 2.5 lb. protein, 13.2 lb. carbohydrates, and .7 lb. fats.
4. For a horse at heavy work: 2.5 lb. protein, 13.3 lb. carbohydrates, and .8 lb. fats.

### Written Problems

**208.** 1. Find the nutritive ratio of the ration consisting of corn fodder, 12 pounds; clover hay, 6 pounds; corn meal, 5 pounds; wheat bran, 2 pounds.

2. Find the nutritive ratio of a ration consisting of corn silage, 32 pounds; clover hay, 8 pounds; corn meal,  $4\frac{1}{2}$  pounds; cottonseed meal,  $1\frac{1}{2}$  pounds.

3. Find the nutritive ratio of the feeding standards in the table on page 199.

4-8. Find the nutritive ratio of the rations Nos. 1 to 5, page 200.

9. Compare the nutritive ratio of the following rations for a milch cow giving 22 lb. of milk daily with that of the feeding standard. Find which is narrow and which is wide. Note which one more nearly meets the requirements of the balanced ration:

**Ration I.** Clover hay 18 pounds, wheat bran 5 pounds, corn meal 6 pounds, linseed meal 1 pound.

**Ration II.** Alfalfa hay 15 pounds, wheat bran 5 pounds, corn meal 6 pounds.

10. In feeding a lot of 10 pigs, whose average weight is 147 pounds, a daily ration of 5.52 pounds

per head consisting of 8 parts corn meal and one part linseed meal is used. Find the nutritive ratio. Is this a wide or narrow ration for a fattening pig during the first fattening period?

#### (4) BALANCED RATIONS

**209.** The practical problem before the farmer and stock feeder of compounding a suitable ration, in view of the fact that feeds are not always available, that market prices vary, and that other conditions must be figured in, must usually be solved by trial. The exact calculation of balanced rations has been worked out mathematically by various writers. However, since a somewhat unbalanced ration is at times the better one, all things considered, and feeding standards are but guides, the method of approximation by trial will be illustrated here.

**FIRST TRIAL RATION FOR A DAIRY COW YIELDING 22 POUNDS OF MILK DAILY**

FEEDING STUFFS	PROTEIN	CARBOHYDRATES	FAT	NUTRITIVE RATIO
Red clover hay, 8 lb. .	.590	3.052	.145	1:5.7
Corn stover, 12 lb. . .	.238	3.979	.068	1:17.4
Corn meal, 5 lb. . .	.313	3.263	.175	1:11.7
Wheat bran, 6 lb. . .	.721	2.474	.172	1:4.0
First trial ration . .	1.862	12.768	.560	1:6.5
Standard ration . . .	2.500	13 000	.500	1:5.7

This trial ration, on comparing with the standard, is seen to be considerably deficient in protein. To make it approximate the balanced form, 2 pounds of cottonseed meal are added.

SECOND TRIAL RATION FOR A DAIRY COW GIVING 22  
POUNDS OF MILK DAILY

FEEDING STUFFS	PROTEIN	CARBOHYDRATES	FAT	NUTRITIVE RATIO
First trial ration . . .	1.862	12.768	.560	1:7.5
Cottonseed meal, 2 lb.	.740	.330	.252	1:1.2
Second trial ration . . .	2.602	13.098	.812	1:5.7
Standard ration . . .	2.500	13.000	.500	1:5.7

All the nutrients in the second trial ration are in slight excess, and the nutritive ratio is close to the standard. Hence, this ought to give satisfactory results.

### Written Exercise

**210.** With the following scale of prices, barley, 65¢; corn, 55¢; oats, 38½¢; bran, \$ 20 per ton; alfalfa hay, \$ 10; timothy hay, \$12.50; prairie hay, \$12.50; alfalfa meal, \$ 14 per ton; linseed meal, \$35 per ton; and silage, \$ 6 per ton, make up a balanced ration for:

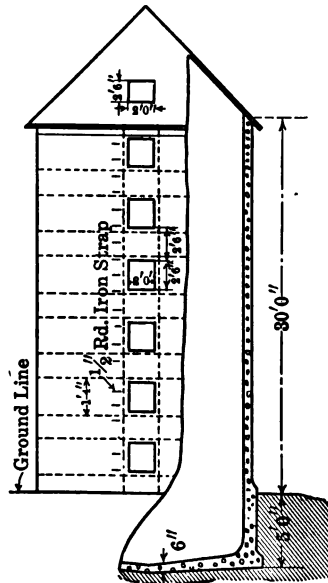
1. A horse doing light work.
2. A horse doing heavy work.
3. A cow giving 16½ pounds of milk daily.
4. A cow giving 22 pounds of milk daily.

5. Fattening cattle during the first period.
6. Fattening swine during the first period.
7. Any other animal raised in your locality using local feeds and prices.

### (5) SILOS

**211.** The silo makes it possible to preserve fodder in its green, succulent state for feeding farm animals, better than is possible by any other system of preservation now known. Most of the present-day silos are built above the ground from such material as wood, cement, steel, brick, hollow tile, etc. Some silos are built square or polygonal, but the round silo gives the best satisfaction.

In the construction of a silo it is very important to have the horizontal dimensions such that not less than  $1\frac{1}{2}$  inches of the top layer of the silage will be fed out daily in order to prevent it from spoiling. The diameter of the silo must, therefore, be planned according to the size of the herd.





The following table shows the computed average weight of well-matured corn silage for silos of different depths, two days after filling. (From *King's Physics of Agriculture*.)

DEPTH	WEIGHT PER CUBIC FOOT	DEPTH	WEIGHT PER CUBIC FOOT	DEPTH	WEIGHT PER CUBIC FOOT
10	26.1	19	32.6	28	38.4
11	26.8	20	33.3	29	39.0
12	27.6	21	33.9	30	39.6
13	28.3	22	34.6	31	40.1
14	29.1	23	35.3	32	40.7
15	29.8	24	35.9	33	41.2
16	30.5	25	36.5	34	41.8
17	31.2	26	37.2	35	42.3
18	31.9	27	37.8	36	42.8

### Written Exercise

**212.** 1. Find the perimeters and areas of the following figures:

- (a) A rectangle 12 by 20 feet.
- (b) A square 16 feet on each side.
- (c) A circle 20 feet in diameter.

2. Compare the amount of wall surface in the following silos:

- (a) A silo with a rectangular base 12 by 20, and 30 feet high.
- (b) A silo 16 by 16, by 30 feet high.
- (c) A silo with a circular base 20 feet in diameter and 30 feet high.

3. If a cubic foot of silage weighs 40 pounds, how many tons will each silo in problem 2 hold?

4. How many 2 by 6 staves would be required to build each of the silos in problem 2; and what would be the cost of the staves for each at \$30 per thousand?

### Written Problems

**213.** 1. What is the capacity in tons of a silo 20 feet in diameter and 32 feet high?

2. The amount of silage that should be fed from such a silo to keep the surface of the silage from spoiling is about 2100 pounds. How many inches in depth will be fed? If a cow eats 45 pounds daily, how many cows should be kept to use the silage fast enough to keep it from spoiling?

3. An eighteen-acre field yields 11.37 tons of silage per acre. What must be the height of a 20-foot silo to hold it if one cubic foot of silage weighs 40.7 pounds? (Give the result to the nearest whole number.)

4. A farmer estimates that he will need 196 tons of silage for the winter. He has purchased staves intended for a silo 36 feet high. What will be the diameter if one cubic foot of silage weighs 42.8 pounds? (Give result to nearest whole number.)

5. A cow should be fed about 40 pounds of silage per day. What should be the diameter of a

24-foot silo in order that  $1\frac{1}{2}$  inches in depth may be fed out daily to a herd of 12 cows?

6. Fattening beef cattle should be fed about 25 pounds a day. What should be the diameter of a 30-foot silo if 2 inches in depth are fed daily to a herd of 60?

7. A silo is 20 feet in diameter and 36 feet high. What is the least number of cows that must be kept to prevent the silage from spoiling if each cow is fed 40 pounds daily?

8. What should be the size of a silo for a herd of 25 cows that are to be fed 40 pounds a day for 180 days at the rate of 2 inches of depth a day? (Give results in nearest whole numbers.)

9. What should be the size of a silo for a herd of 60 fattening cattle fed 30 pounds a day for 216 days at the rate of 2 inches of depth per day? (Give results in nearest whole numbers.)

10. What must be the diameter of a silo to hold twice as much as a silo 30 feet high and 20 feet in diameter if their heights are the same?

11. Some authorities estimate that 5 square feet of horizontal feeding surface should be allowed for each cow. What should be the diameter of a silo for a herd of 36 cows?

12. Allowing 5 square feet per cow as in problem 11, what should be the diameter of a silo for a herd of 45 cows?

13. From 29,800 pounds of green fodder turned into silage fed with hay and grain, 7496 pounds of milk, containing 340.4 pounds of fat, were produced; and from the same number of pounds of green fodder, field-cured, fed with the same amount of hay and grain, 7119 pounds of milk and 318.2 pounds of fat were produced. What was the per cent of increase in the amount of milk? In the amount of butter fat?

14. In an experiment with silage for fattening cattle at the Kansas station, it was found that 156 pounds of alfalfa hay was equivalent in feeding value to 461 pounds of silage. If alfalfa hay is worth \$ 12.50 per ton, what is the value of silage per ton?

15. If a silo is 18 feet in diameter, inside measure, and 32 feet high, how many cubic yards of concrete will it take to build it if the wall and floor are each 6 inches thick, and the foundation is 8 inches thick and 5 feet deep?

16. If a  $1:1\frac{1}{2}:3$  mixture is used, how many sacks of cement, cubic yards of sand, and cubic yards of gravel will be needed?

## PROPORTION

### Study Exercise

**214. Proportion** is a statement of the equality between two ratios. It is written in two ways, as

indicated in the following example:  $3:5 = 18:30$  or  $3:5::18:30$ . In either form it is read 3 is to 5 as 18 is to 30 and means the same as  $\frac{3}{5} = \frac{18}{30}$ . Any proportion may be written in the fractional form.

The **extremes** of a proportion are the first and last terms; and the **means** are the second and third terms. The antecedents are the first and third terms, and the consequents are the second and fourth. In most of the simple problems of proportion the following important fact is used: viz., **The product of the means is equal to the product of the extremes.** Thus: in  $4:3 = 12:9$ , the product of the extremes is 36, as is also the product of the means.

From the above principle the following **two practical rules** concerning the terms of a proportion are easily derived:

1. **Either extreme equals the product of the means divided by the other extreme.**

2. **Either mean equals the product of the extremes divided by the other mean.**

1. Find the value of  $x$  in the proportion  $16:25 = 12:x$ .

**Process**

$$16:25 = 12:x$$

$$16x = 25 \times 12$$

$$16x = 300$$

$$x = \frac{300}{16} = 18\frac{3}{4}. \quad \text{Ans.}$$

**Explanation:** Product of means equals the product of extremes.

**Written Exercise**

**215.** Find the values of  $x$  in the following proportions:

- |                    |   |
|--------------------|---|
| 1. $x:39::15:13.$  | 6. $179.2:x::25.6:5.1.$                           |
| 2. $95:x::19:5.$   | 7. $x:4.15::65:7.2.$                              |
| 3. $108:93::x:31.$ | 8. $8\frac{2}{3}:14\frac{3}{4}::25\frac{1}{5}:x.$ |
| 4. $680:36::70:x.$ | 9. $7\frac{4}{5}:4\frac{2}{3}::x:9.$              |
| 5. $22:x::34:55.$  | 10. $x:13::14:117.$                               |

**Written Problems**

**216. 1.** If 8 tons of coal cost \$46, what will 25 tons cost at the same rate?

This problem can be put into the form of a proportion, since the same relation holds between the amounts of coal as between the cost prices. Hence, we have  $8:25::\$46:\$x$ .

**2.** An express train runs 50 miles in 70 minutes. At the same rate, how many miles will it run in 40 minutes?

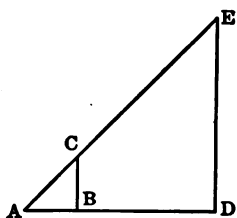
**3.** Assuming the ratio of the circumference of a circle to the diameter as  $\frac{22}{7}$ , find the circumference of a fly wheel 8 feet in diameter.

**4.** If a farmer sells 5 tons of hay for \$45, how much will he receive for 20 tons at the same rate?

**5.** If 6 men can do a piece of work in 15 days, how long will it take 10 men to do the same work?

6. If a post 24 feet high casts a shadow 32 feet long, at the same time how long is the shadow of a tree which is 80 feet high?

7. The height of a tall object may be found by means of proportion. The accompanying figure shows how to measure the height of a tree.



The man holds a right triangle in which  $AB$  equals  $BC$ . Keeping  $AB$  level, he moves until the top of the tree just comes in line with  $AC$ . Since the proportion  $AB:BC::AD:DE$  holds where  $AB$  equals  $BC$ , it follows that  $AD$  equals  $DE$ . Hence, it follows that the entire height of the tree is readily found by a horizontal ground measurement.

8. A farmer in planting potatoes used two different sizes for seed. The small seed yielded 141 bushels per acre, and the large 28 % more. Find the yield in bushels per acre of the large seed.

9. If in 10 pounds of a certain fertilizer there are .47 pound of nitrogen, .988 pound of phosphorus, and .478 pound of potash, how many pounds of each of these are there in one ton of fertilizer?

10. At the Kansas Experiment Station in 1912, the total yield of alfalfa for the season in pounds per acre was 5370 on a fertilized plot and 4390 on an unfertilized plot. The value of the yield per

acre of the unfertilized plot was \$21.95 and the cost of fertilizing was \$2.09. Determine the net increase in financial returns per acre due to fertilizing.

11. If in corn there is 10.6 % water, 1.5 % ash, 10.3 % protein, 72.6 % carbohydrates, and 5 % fats, how much of each of these is there in 3000 pounds of corn?

12. A fertilizer has 4.54 % of nitrogen, 7.82 % of phosphoric acid, 7.94 % of potash. Find the price of a ton of the fertilizer if nitrogen is worth 17¢ per pound, phosphoric acid 4.5¢, and potash 5¢.

13. If 8 bushels of wheat will seed 5 acres of land, how many bushels will be required to seed a field 60 rods wide and 95 rods long?

14. A garrison of 480 men has provisions to last during a certain period at the rate of 2 pounds, 4 ounces per day for each man. If the allowance is reduced to 1 pound, 4 ounces per day, how many men could be added to the garrison?

15. If 4 pounds of cotton-seed meal are equal to 7 pounds of corn for cattle feeding, what is the value of a ton of cotton-seed meal for cattle feeding when corn is worth 45¢ a bushel?

16. Measure the height of a post and the length of its shadow; also, at the same time, measure the length of the shadow of some tall object, and calculate its height.



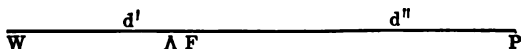
## APPLICATIONS OF PROPORTION

### LEVERS

**217.** A **lever** is a rigid rod which can be moved freely about a fixed point. The principle of the lever is an important one and enters into such common implements as the hammer, crowbar, etc. In the theory of levers three elements must be considered:

- (1) The power applied.
- (2) The weight moved.
- (3) The fulcrum, or fixed point on which the lever turns.

In the accompanying figure  $F$  stands for the fulcrum,  $W$  for the weight,  $P$  for the power,  $d''$  for the



distance from the fulcrum to the point of application of the force, and  $d'$  for the distance from the fulcrum to the point where the weight is attached. The following proportion holds in all cases:  
 $W : P :: d'' : d'$ .

### Oral Exercise

**218.** 1. In the foregoing figure, if the fulcrum is moved toward the weight, what will be the effect upon the force required to lift the weight?

2. Answer the corresponding question in case the fulcrum is moved toward the point of application of the power.

3. If  $d'$  and  $d''$  are equal to 4 and 1 respectively, how many pounds must be exerted to lift a weight of 80 pounds? Of 120 pounds?

4. Under the same conditions as in exercise 3, how heavy a weight can be lifted by applying a force of 25 pounds? Of 40? Of  $7\frac{1}{2}$ ?

5. Locate the fulcrum, weight, and power in a pair of scissors; in nutcrackers.

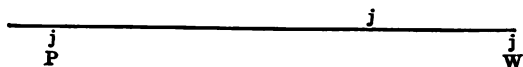
### Written Problems

219. 1. A man weighing 150 pounds, wishing to raise a stone, puts his weight on the end of a straight crowbar,  $4\frac{1}{2}$  feet long, which rests on a block 5 inches from the stone. What force does he exert on the stone?

2. In a pair of nutcrackers the nut is placed at a distance of  $1\frac{1}{2}$  inches from the hinge. With a pressure of 60 pounds exerted at the distance of 8 inches from the hinge, how much resistance can be overcome?

3. Two children, playing seesaw at opposite ends of a plank 14 feet long, weigh 48 pounds and 70 pounds respectively. Find the distance of each child from the fulcrum.

4. With steelyards as in the adjoining figure, what must be the weight,  $P$ , to balance a weight,

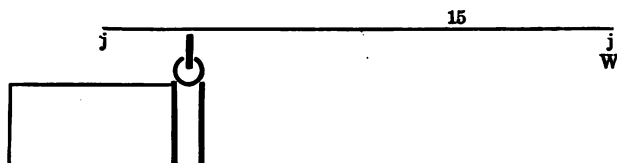


$W$ , of 20 pounds if it is  $2\frac{1}{2}$  inches from the fulcrum to the application of  $W$  and 12 inches from the application  $P$ ?

5. In cutting a piece of tin with a pair of shears, the point of contact with the tin is  $\frac{3}{4}$  inch from the fulcrum, and the pressure is exerted at a distance of 7 inches from the fulcrum. Find the force exerted by the hand if the resistance of the tin is 480 pounds.

6. In pulling a nail from a board with a hammer, the distance from the fulcrum to the nail is  $1\frac{3}{4}$  inches and from the fulcrum to the hand is  $10\frac{1}{2}$  inches. Find the resistance of the nail for a pull of 80 pounds upon the hammer handle.

7. A safety valve is set to pop at 160 pounds per square inch. The short arm lever is 3 inches, the long arm 15 inches. The diameter of the valve is 2 inches. What weight must be attached to the lever?



8. If a weight of 10 pounds is fastened to the long arm of the lever, at what pressure will it pop?

## GENERAL REVIEW

### MISCELLANEOUS PROBLEMS

**220.** 1. Zintheo figures that the depreciation in value of a corn harvester is \$22.50 per year. If the twine and labor cost 75¢ per acre, what is the cost of harvesting 10 acres, not counting the shocking and hauling to the silo? If the cost of harvesting by hand is \$1.50 per acre, which is the cheaper plan of harvesting and how much? If the shocking costs 45¢ and hauling to the silo \$1.10 per acre, what is the total cost per acre when the harvester is used?

2. Find the cost of material needed to make a green sand mold as follows: Green sand or molding sand, 25 pounds at  $\frac{3}{5}$ ¢ per pound, 1 pound of sea coal at  $1\frac{1}{2}$ ¢ per pound, 2 pounds of parting sand at  $\frac{2}{3}$ ¢ per pound, 4 patterns at  $5\frac{3}{4}$ ¢ each, and  $\frac{1}{4}$  pound of graphite at 15¢ per pound.

3. A field is  $\frac{1}{2}$  mile long and  $\frac{1}{4}$  mile wide. If a gang plow cuts 28 inches, how many acres does a man plow in 9 rounds?

4. Sprayed grapes yielded 3 pounds  $4\frac{3}{10}$  ounces more per row than unsprayed grapes. What was the increased yield on 17 rows?

5. How many plants can be set on a plot 15 feet square so that no two will be nearer than  $\frac{1}{2}$  foot apart? Illustrate with drawing.

6. What will it cost to build a concrete walk 3 feet wide around the outside of an 80-foot square court at 13 ¢ per square foot?

7. A fence around a square field costs \$35.20 at 16 ¢ per rod. What would have been the cost if the field had been in the form of a rectangle with a width of 45 rods?

8. How long must a tape line be to wind a spiral around a cylinder that is 50 feet long and 8 feet in circumference, if it passes once around in every 6 feet of the cylinder's length?

9. A field is 40 by 20 rods. What will it cost to put a wire fence around it at 22 ¢ per rod for the wire and 17 ¢ for each post, if the posts are one rod apart?

10. A field is 80 rods long and 35 rods wide. What is the width of a similar field whose length is 48 rods?

11. A border is to be placed about a square with an area that is one half of the square. If the side of the square is 8 inches, what are the outside dimensions of the border?

12. Show that the area of a square circumscribed about a circle 8 inches in diameter is twice the size of a square inscribed in the same circle.

13. What is the depth of a cubical vat that holds ten gallons of water?

14. Draw to scale of  $\frac{1}{4}$  inch to the rod, a diagram of a rectangular field 24 by 30 rods. What would be the value of the land at \$75 per acre?

15. A ten-acre field in the form of a square was laid out into lots. A strip 30 feet wide was taken from each of the sides. The field was now divided into four lots by alleys running full length through the center. Both alleys were 60 feet wide. What were the dimensions of the lots? Draw to scale, using  $\frac{1}{4}$  inch to the rod.

16. One of the bases of a trapezoid is 10 feet, the altitude is 4 feet, and the area is 32 square feet. What is the length of a line between the bases and parallel to them that is 1 foot distant from the 10-foot base?

17. A room is 24 by 18 by 10 feet. What will it cost to plaster the room at 20¢ per square yard, making deductions for two doors, 6 by  $3\frac{1}{2}$  feet; three windows, 6 by 3 feet; and a 9-inch base-board?

18. Find the weight of wheat that will fill a bin 8 by 6 by 5 feet.

19. What is the cost of 3260 pounds of oats at 40¢ per bushel and 4680 pounds of wheat at 95¢ per bushel?

20. Ten loads of corn weigh 3200, 3150, 3280, 2860, 2950, 2870, 2900, 3140, 3300, 3080 pounds, respectively. What will the corn bring at 58¢ per bushel?

21. If a railway right-of-way is 66 feet wide, how many miles in length must it be to contain an acre?

22. If you multiply the diameter of a circle by .7071, the result is the side of an inscribed square. Why is this?

23. Show that it will take 350 posts 8 feet apart for a fence inclosing a field that is 600 by 800 feet.

24. A cistern is 6 feet in diameter. How much will a one-inch rain upon a roof that is 60 by 40 feet raise the level of the water?

25. An ordinary lead pencil is 6 inches long and  $\frac{1}{4}$  inch in diameter. If the lead in the pencil is  $\frac{1}{16}$  inch in diameter, what is the volume of the entire pencil? Of the lead? Of the wood?

26. A box is to be made 8 feet 3 inches by 4 feet 9 inches by 3 feet 11 inches, inside measurements. How much 1-inch lumber will it take to make the box without a lid?

27. An excavation for a cellar is 60 by 30 by 8 feet. How many cubic feet of concrete are in the walls if they are 18 inches thick?

28. A contractor agreed to furnish the paint and give two coats to five ceilings that were 30 by 27 feet, for \$ 75. What was the cost per square yard to the owner?

29. I measure directly east from a point  $A$  to a point  $B$ , then north 144 feet to a point  $C$ . From point  $C$  I measure directly east again to a point  $D$ , a distance of 160 feet. What is the distance  $BD$ ?

30. A cylindrical water tank is 18 feet in diameter and 30 feet high. If it is  $\frac{3}{4}$  full, what will be the weight of the water in the tank?

31. On a strip of ground 100 by 80 feet a boy raises 122 bushels of potatoes. At the same rate, what would be the yield per acre?

32. If corn is planted so that the hills are 3 feet 8 inches apart, what will be the number of hills to the acre?

33. Show that, if you multiply the side of a square inscribed in a circle by 1.4142, the result is the side of a circumscribed square.

34. Dwarf pear trees are usually 15 feet apart each way. How many trees per acre?

35. What will 14 bushels 3 pecks 4 quarts of charcoal cost at 62 ¢ per bushel?

36. At \$ 690.75 per mile, what is the cost of a road 17 miles long?

37. How many square yards of plastering will be required for the ceiling and walls of a room 10 by 15



by 9 feet? The room has one door  $3\frac{1}{2}$  by 7 feet, three windows  $3\frac{1}{2}$  by 6 feet, and an 8-inch baseboard.

38. Find the area of a flat circular ring whose outside diameter is 12 inches and inside diameter 6 inches.

39. A body floating in water displaces its own weight. A battleship weighs 31,400 tons. How many gallons of water does it displace? How many cubic feet?

40. How many cubic feet of concrete are there in a battered retaining wall 15 feet high, 2 feet thick at the top, and 5 feet thick at the bottom, and 50 feet long? How many sacks of cement will be required for the wall if a 1 : 3 : 6 mixture is used?

41. Find the diameter of the down spout of a roof 60 by 120 feet, using 1 square inch of pipe area for every 175 feet of roof area.

42. Find the diameter for a cast-iron bearing plate for a column load of 40,000 pounds on a concrete pier, allowing 200 pounds per square inch as a safe strength of concrete.

43. Find the weight of a cast-iron column 10 feet long, 10 inches in diameter, and 1 inch thick, if cast iron weighs 450 pounds per cubic foot.

44. To irrigate a 20-acre field water is run full bore through a 6-inch pipe with a velocity of one foot per second. How long will it take to deliver one inch of water over the entire field?

45. In a certain town a cylindrical water tank 48 feet in diameter is lowered 5 feet, when no water is being pumped into it, in 5 hours and 30 minutes. How many gallons are being removed per hour?

46. A cow is tied to the corner post of a rectangular field by a rope 40 feet long. Over what part of an acre can she feed?

47. How many acres of corn will it require to produce the silage to feed 20 cows 36 pounds each day for 120 days, if each acre yields  $12\frac{1}{2}$  tons of silage? What must be the diameter of the silo necessary to hold this silage if its height is 24 feet, and one cubic foot of silage weighs 35 pounds?

48. Make a graphic chart, illustrating the moisture content of three adjoining fields cropped to alfalfa, wheat, and corn, respectively, soil samples in the experiment being taken to a depth of six feet. Use straight lines in the drawings obtained from the following data:

MONTH	AMT. OF MOISTURE IN INCHES			MONTH	AMT. OF MOISTURE IN INCHES		
	Alfalfa	Wheat	Corn		Alfalfa	Wheat	Corn
Jan. . .	17.1	22.8	23.0	July . .	12.2	18.3	16.0
Feb. . .	17.0	21.9	19.0	Aug. . .	12.5	18.7	17.0
Mar. . .	17.4	21.8	22.5	Sept. . .	12.3	18.4	16.5
April . .	13.7	17.2	19.6	Oct. . .	12.1	19.6	18.3
May . .	11.6	15.3	21.2	Nov. . .	13.6	19.8	19.2
June . .	15.2	20.3	22.9	Dec. . .	12.1	17.5	16.8

49. Represent graphically the results of the following experiment at the Illinois station to determine the effects upon milk production of a balanced ration. The data give the weekly milk production per cow of lots I and II of a dairy herd fed on a balanced ration and an unbalanced ration, respectively:

TIME	POUNDS OF MILK PER WEEK		TIME	POUNDS OF MILK PER WEEK	
	Lot I	Lot II		Lot I	Lot II
Jan. 7 .	257	216	Feb. 18 .	250	160
Jan. 14 .	243	202	Feb. 25 .	251	162
Jan. 21 .	245	192	Mar. 4 .	244	157
Jan. 28 .	251	184	Mar. 11 .	236	149
Feb. 4 .	252	174	Mar. 18 .	221	144
Feb. 11 .	247	169	Mar. 25 .	219	143

Judge from the space between the two graphs as to the difference in milk production.

50. Water enters a tank through two pipes having diameters of  $\frac{3}{4}$  inch and  $1\frac{1}{4}$  inches, respectively. Find the size of the waste pipe that will allow the water to run out as fast as it runs in.

51. If the fire under a steam boiler requires 4 pounds of coal per horsepower per hour, find the cost of coal at \$4.25 per ton to run a 150-horsepower boiler for 20 days of 10 hours each.

52. On a poor road a farmer can haul  $\frac{7}{8}$  ton at a load, and on a good road  $1\frac{1}{2}$  tons. Allowing

three loads per day on a poor road and four loads per day on a good road, what is the loss at \$ 3.75 per day in marketing over the poor road 675 bushels of corn (70 pounds per bushel)?

53. The trade route from San Francisco to New York is 5240 miles by way of the Panama Canal. This is 62 % shorter than the route by Cape Horn. What is the length of the route by Cape Horn?

54. Wheat loses about 18 % by weight when ground into flour. How many bushels are required to make a barrel of flour (196 pounds)?

55. If wheat is worth \$1 per bushel and a barrel of flour sells for \$ 4.85, what is the amount received for milling and packing?

56. How many 12-ounce loaves of bread can be made from a barrel of flour if the weight of the bread is  $133\frac{1}{3}$  % of the weight of the flour used in making it? What would be the selling price for a barrel of flour at 5¢ a loaf for the bread?

57. The average workman should eat daily a certain weight of starchy food, 16 % of that weight of fats, and 20 % of that weight of albuminous substances. The total weight of these three food substances should be at least  $1\frac{1}{2}$  pounds daily. What weight of each is required?

58. About 11.2 % of an egg is shell. When eggs are 35¢ per dozen, what is spent for waste material?

59. Cooked eggs contain 12% protein and cooked roast beef 22.3% protein. If one egg weighs 2 ounces, how many eggs will furnish as much protein as 1 pound of roast beef?

60. The total weight of an egg is 1.88 ounces. If 1.07 ounces were white, .62 ounce was yolk, and .19 ounce was water, what per cent of each made up the egg?

61. Milk contains about 87% water. If 1 cup of milk weighs  $8\frac{1}{8}$  ounces, how many pints of water are found in a gallon of milk?

62. Milk contains about 3% protein. If  $\frac{5}{8}$  of the protein is casein and  $\frac{1}{8}$  albumen, what is the per cent of casein and albumen in milk?

63. Cooked eggs contain 13% protein. What quantity of milk contains the same amount of protein as one dozen eggs?

64. How much lace is needed to put around a dusting cap which is 18 inches in diameter?

65. A man sold two engines for \$2500 each. On one he lost 25% and on the other he gained 25%. Did he gain or lose on the entire transaction and how much?

66. In unskimmed milk .88 is water, .2 is fat, .04 is protein, and .05 is carbohydrates. How much of each is there in a gallon of milk?

67. In testing wheat for seed a man found 375 good seeds out of every 425. What per cent of the

seeds were good? If he paid 90¢ per bushel, what was the price paid for a bushel of good seed?

68. A man purchased 30 head of cattle for \$1500 and kept them four months. During that time he fed them an average of  $\frac{1}{2}$  ton of alfalfa hay per head valued at \$17 per ton,  $\frac{1}{3}$  bushel of corn per day per head at 75¢ per bushel, and 100 tons of silage valued at \$5 per ton. What was the selling price per head in order to realize a gain of 10%?

69. A farmer offers to sell a horse for \$180 cash, or for wheat valued at \$200. What will he receive for the horse if he is paid 50% in cash and the remainder in wheat? Show that it is not \$190.

70. The *New Hampshire* received 2250 tons of coal on board during a recent coaling. During the next two weeks 1575 tons of it were burned. What per cent of the coal remained?

71. Water in freezing expands 10% of its volume. How much water when frozen will just fill a five-gallon freezer?

72. At the Kansas Experiment Station in 1912 potatoes raised on one plot which was plowed in March yielded 258 bushels per acre; when plowed in September and then in March, the yield was then 287 bushels; when plowed in July and then in March, 339 bushels. What was the per cent of increase of each yield over that of the spring plowing?

73. On September 9, 1907, 1445 wheat plants were examined for Hessian flies and 119 plants were infested. What per cent were infested?

74. The average number of Hessian flies emerging from a plot of untreated ground was 25. By burning the trash on the ground, plowing, disking, etc., only an average of one fly emerged. What was the per cent of gain in destruction of the flies made by treating the ground?

75. If alfalfa hay contains 10.58 % protein, 37.33 % carbohydrates, and 1.38 % fats; and timothy hay contains 2.89 % protein, 43.72 % carbohydrates, and 1.43 % fats, what is the difference in the feeding value of a ton of alfalfa hay and a ton of timothy hay, estimating protein at  $3\frac{1}{2}$  ¢ a pound, carbohydrates at 1 ¢ a pound, and fats at  $2\frac{1}{2}$  ¢ a pound?

76. Which is cheaper, a ton of 3:8:3 fertilizer at \$21, or a ton of 4:6:3 fertilizer at \$24, valuing nitrogen at 18 ¢, phosphoric acid at 5 ¢, and potash at 5 ¢ per pound?

77. A cow gives during a certain month 925 pounds of milk yielding 3.2 % butter fat. If the butter fat produces  $\frac{5}{4}$  of its weight in butter, what is the value of the butter that can be made from it at 25 ¢ per pound?

78. I bought a 6 % \$2500 mortgage at 5 % discount, with two years to run. What per cent

of interest is realized on the money if the mortgage is paid at maturity?

79. My agent sold goods to the amount of \$4620. If he paid \$85 for cartage and other expenses, and charged 3 % commission, what were the net profits?

80. The usual charge at the Chicago stockyards for selling beef cattle is 50 ¢ per head. Find the per cent of commission on 35 head of cattle weighing 1250 pounds each and selling for \$7.15 per hundredweight.

81. A commission merchant sells 7000 pounds of cotton at 15 ¢ per pound, charging  $2\frac{1}{2}$  % commission. With the net proceeds he buys cotton cloth at 12 ¢ per yard, charging 2 % commission for buying. How many yards of cloth does he buy?

82. A man's house was damaged by a wind storm to the extent of 30 % of its value. He received from the insurance company in which the house was insured for 80 % of its value, the sum of \$984, covering the loss. What was the value of the house?

83. If under like field conditions one variety of wheat yields 6 bushels per acre more than another variety, find the gain in planting the better variety on 120 acres, if the poor seed costs 65 ¢ and the better seed \$1.45 per bushel. Allow 7 pecks of seed wheat per acre and reckon the value of the wheat at 95 ¢ per bushel.



84. In a hog-fattening experiment it was found that 4.25 pounds of a ration, consisting of 5 parts of corn meal and 1 part of tankage, produced 1 pound of gain, and that 7.28 pounds of a corn meal ration produced 1 pound of gain. Determine in each case the cost of feed per 100 pounds of gain; also find the amount saved per 100 pounds of gain each for 15 hogs, by use of the first ration. Value corn meal at 95¢ per hundredweight and tankage at  $2\frac{1}{4}$ ¢ per pound.

85. At a distance of 60 feet from a windmill is a post 10 feet high. By standing back of the post 6 feet and sighting over a 4-foot stick the top of the windmill and the top of the post are in line. How high is the windmill?

86. A common brick weighs  $4\frac{1}{8}$  pounds. What is its specific gravity?

87. A cubic foot of salt water weighs 64.375 pounds. What does a column of water weigh that is 1 foot square and 60.5 feet high?

88. The specific gravity of ice is .92. What is the weight of a block of ice that is 18 by 18 inches and 3 feet long?

89. The specific gravity of machine oil is .886. What is the weight of a barrel of oil?

90. Steel expands about .00000636 of an inch for every inch when the temperature is increased 1 degree F. What is the increase in length of a

rail for a railroad, if the rail is 60 feet long and the temperature rises 5 degrees? What would be the increase in length if there were a change from a winter temperature of 8 degrees below zero to a summer heat of 90 degrees?

91. What is the weight of a cubic inch of gold if its specific gravity is 19.245? Of mercury, specific gravity of 13.587? Of lead, specific gravity of 11.07?

92. A dairy cow requires 1 pound of protein to 6 pounds of carbohydrates in her food. Dry peas contain 10 pounds protein and 32 pounds carbohydrates per bushel (60 lb.). Hay contains 88 pounds of protein and 880 pounds of carbohydrates per ton. What should be the proportion of the quantities of dry peas and hay fed to a dairy cow, if these are to constitute her feed?

93. How many gallons each of cream containing 30 % fat and milk containing 5 % fat, can be mixed so as to produce 10 gallons of cream containing 25 % fat?

94. A 65-foot ladder rests against a building, its foot being 39 feet from the wall. How high does it reach?

95. Three men owning lots with frontages of 40, 55, and 65 feet respectively on the same street are assessed \$475 for curbing and paving. Find the share of each.

96. If a water pipe can fill a cistern holding 90 barrels in 32 minutes 30 seconds, how long will it take for the same pipe to fill a cistern holding 145 barrels?

97. Find to two decimal places the diagonal of a square field containing 17 acres 110 sq. rd.

98. A cotton planter mixed a ton of fertilizer for his land, containing 85 parts of acid phosphate, 105 parts of cotton seed meal, and 10 parts of muriate of potash. What was the cost of the fertilizer if the prices of the ingredients were \$10.75, \$25.40, and \$41.25 per ton respectively?

99. A 1916 bulletin issued by the United States Department of Agriculture on the Cost of Fencing in the Central States shows that there are 6,361,502 farms in the United States averaging 138.1 acres and requiring on the average 6 rods of fence per acre. What is the total number of rods of fence? The total number of miles? How many times would this number of miles of fence encircle the earth?

100. To replace this with a medium grade of woven wire fence would cost 65¢ a rod. What would be the total cost of the fence in problem 99?

101. The cost of the fence in problem 100 is 8.3% of the value of the farm property and 12% of the value of the farm land in the United States. What is the value of each?

## APPENDIX I

### WEIGHTS OF PRODUCE

I. The following are the weights per bushel of certain articles according to the laws of the various states :

Wheat . . . . .	60 lb. in all states.
Ear corn . . . . .	70 lb. in all except Ohio 68 lb. ; in Indiana after Dec. 1, and in Kentucky after May 1, 68 lb.
Shelled corn . . . . .	56 lb. except California 52 lb.
Oats . . . . .	32 lb. except Idaho 36 lb. ; Maryland 26 lb. ; Virginia and New Jersey 30 lb.
Rye . . . . .	56 lb. except California 54 lb. ; Maine 50 lb.
Barley . . . . .	48 lb. except Oregon 46 lb. ; Califor- nia 50 lb. ; Alabama, Georgia, Kentucky, Pennsylvania 47 lb.
Beans . . . . .	60 lb. in all states.
Peas . . . . .	60 lb. in all states.
Potatoes . . . . .	60 lb. except Maryland, Pennsyl- vania, and Virginia 56 lb.
Sweet potatoes . . . . .	55 lb. in most states, 50 lb. in Kansas.
Onions . . . . .	57 lb. in nearly all states.
Turnips . . . . .	55 lb. in all states.
Clover seed . . . . .	60 lb. except New Jersey 64 lb.
Alfalfa . . . . .	60 lb. except New Jersey 64 lb.
Timothy seed . . . . .	45 lb. except Arkansas 60 lb. ; North Dakota and Oklahoma 42 lb.

Hungarian grass seed	50 lb. in all states.
Millet . . . . .	50 lb. in all states.
Flax seed . . . . .	56 lb. in all states.
Blue-grass seed . . .	14 lb. in all states.
Coal . . . . .	80 lb. in all states.
Apples . . . . .	48 lb. except Arkansas, Minnesota, New Jersey, North Dakota, Ohio, Tennessee, and Wisconsin 50 lb.; Idaho, Montana, Oregon, Texas, and Washington 45 lb.; Maine 44 lb.
Bran . . . . .	20 lb. in all states.

### IMPORTANT FACTS

II. 1 cubic foot of water weighs  $62\frac{1}{2}$  pounds or 1000 ounces.

1 gallon of water weighs  $8\frac{1}{3}$  pounds.

1 cubic foot of water equals  $7\frac{1}{2}$  gallons.

1 cubic foot equals  $\frac{1}{4}$  of a bushel.

1 pound avoirdupois equals 7000 grains.

1 pound Troy equals 5760 grains.

1 barrel equals  $31\frac{1}{2}$  gallons or 4.211 cubic feet.

196 pounds of flour equals one barrel.

200 pounds of pork or beef equals one barrel.

### SPECIAL RULES

III. The surface of a pyramid or cone equals one half the perimeter of the base times the slant height.

The volume of a pyramid or cone equals one third the area of the base times the height.

The surface of the frustum of a pyramid or cone equals one half the slant height times the sum of the perimeters of the two bases.

The volume of the frustum of a pyramid or cone equals  $\frac{1}{3}$  the height times the sum of the two bases plus the square root of their product.

The surface of a sphere equals  $4\pi$  times the square of the radius.

The volume of a sphere equals  $\frac{4}{3}\pi$  times the radius cubed.

## HAY MEASUREMENTS

IV. To measure hay in the mow, multiply the length, width, and depth in feet together and divide by 405, if the hay is well settled and the mow deep. If the mow is shallow and recently filled allow 512 cubic feet to the ton.

Alfalfa hay that has been stacked 30 days will require about 512 cubic feet for a ton. When the hay has been stacked 5 or 6 months, usually 422 cubic feet is calculated for a ton. In old fully settled stacks, about 350 cubic feet will be about right.

To find the number of tons in a rick, measure the distance in feet from the bottom of the rick on one side to the bottom on the other; add to this the average width of the rick in feet, divide this sum by 4 and multiply the quotient by itself and this product by the length of the rick in feet. This will give the number of cubic feet in the rick. Divide by 512, 422, or 350 to find the number of tons.

For a conical stack: find the circumference at or above the base or bulge at a height that will average the base from there to the ground; find the vertical height of the measured circumference from the ground and the slant height from the measured circumference to the top of the stack in feet. Multiply the circumference by itself; divide by 100; and multiply by 8; then multiply the result by the height of the base plus one third of the slant height of the top. Divide by 512, 422, or 350 to find the number of tons.

## APPENDIX II

### MISCELLANEOUS MEASURES

#### V. Tables for Reference

USE THIS SPECIAL LINEAR UNITS TABLE FOR  
REFERENCE

1 hand	= 4 inches.	Used in measuring the height of a horse.
1 fathom	= 6 feet.	Used in measuring depths at sea.
1 knot (geog. mile)	= $1.152\frac{1}{2}$ miles or 6086 ft.	Used for measuring distances at sea.

#### Paper

TABLE FOR REFERENCE

24 sheets	= 1 quire
20 quires	= 1 ream
2 reams	= 1 bundle
5 bundles	= 1 bale

This table for counting sheets of paper was formerly used extensively in the printing and publishing business. Paper is now usually counted in bundles of 500 sheets.

**Counting****USE THE TABLE IN COUNTING**

12 things = 1 dozen (doz.)

20 things = 1 score

12 dozen = 1 gross

12 gross = 1 great gross

**Circular Measure**

**Circular Measure** is used in measuring angles or arcs of circles. The unit is the degree which is  $\frac{1}{360}$  of the circumference of a circle. At the equator 1 degree equals  $69\frac{1}{8}$  miles, or 60 knots.

**TABLE FOR REFERENCE**

60 seconds(") = 1 minute (')

60 minutes = 1 degree (°)

360 degrees = 1 circumference

**Troy Weight**

**Troy Weight** is used in weighing diamonds, gold, silver, and other precious metals.

**TABLE FOR REFERENCE**

24 grains (gr.) = 1 pennyweight (pwt.)

20 pennyweight = 1 ounce

12 ounces = 1 pound





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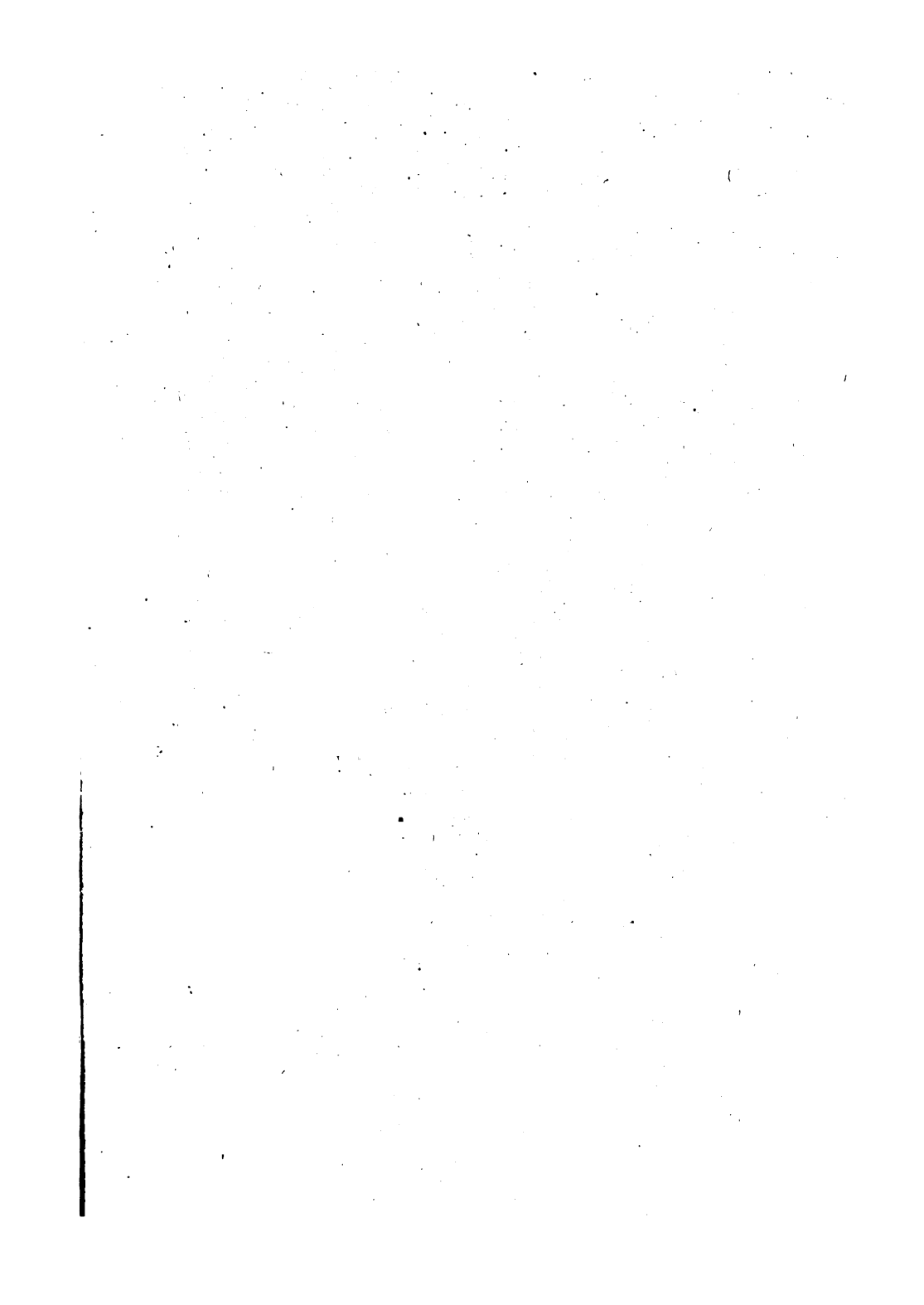
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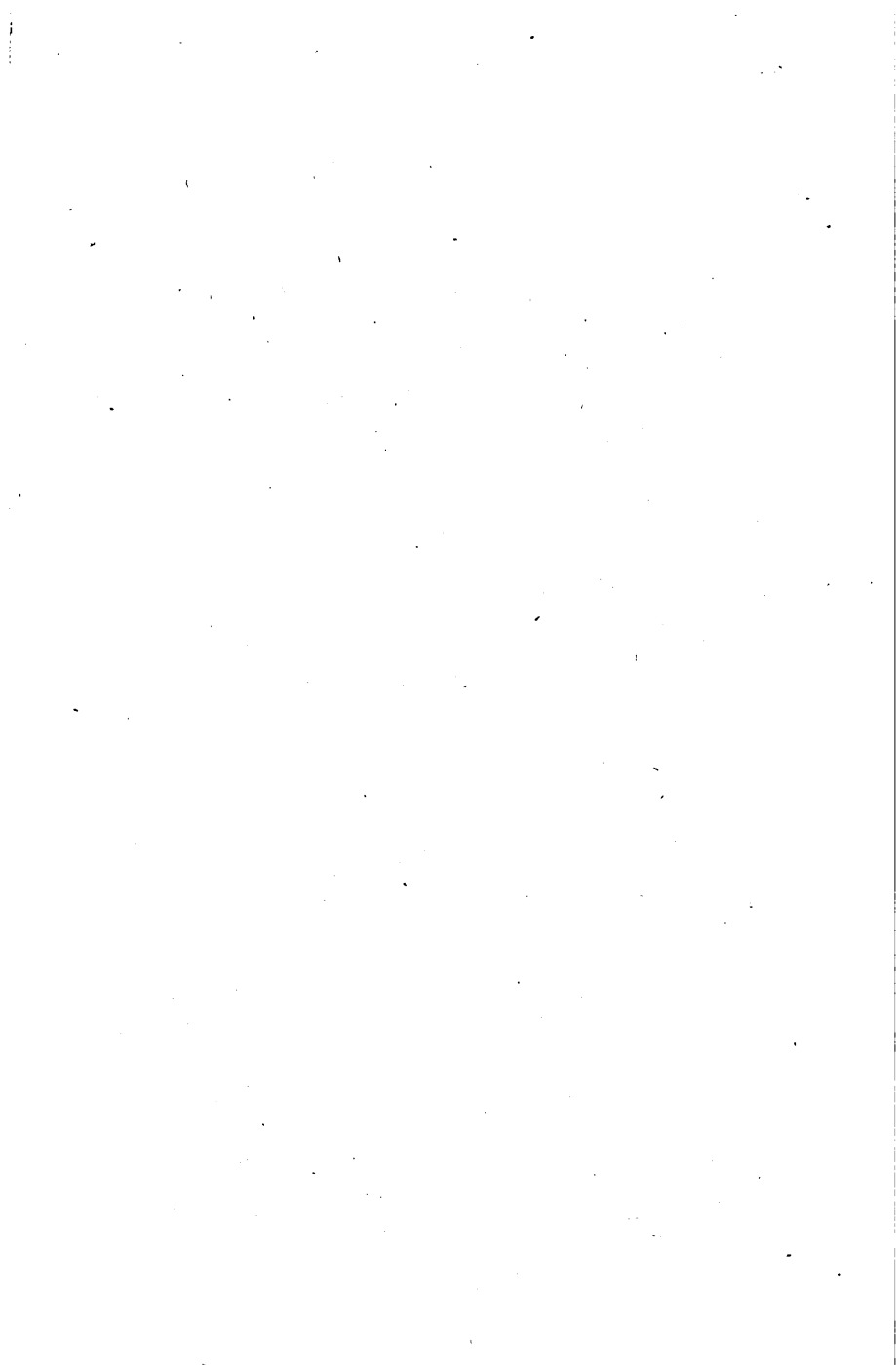
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